

## CHAPTER 4

### RESULTS

#### 4.1 INTRODUCTION

Results of the calculation of loadings of materials discharged to Galveston Bay are given in this chapter. These loadings are for the point sources considered here to be from permitted wastewater discharges and from major tributaries entering the Bay. The latter category included materials leaving Lake Livingston and Lake Houston over its spillway.

#### 4.2 PERMITTED POINT SOURCE LOADING

##### 4.2.1 Introduction

Loadings from permitted point source loads for the constituents or discharge conditions listed in Table 3.2 were estimated. For permitted point sources into the Galveston Bay system, good estimates of loading were available from the information reported by the dischargers for some constituents. For many constituents, few permittees were required to report concentrations or loadings. Of the approximately 730 active permitted discharges examined, the following numbers and percentages of dischargers self-report for the indicated constituents:

Flow/Constituent	No. Permittees Reporting	Percent of Permittees Reporting
Flow	725	99.04%
BOD <sub>5</sub>	509	69.54%
Total Suspended Solids	664	90.71%
Nitrogen Forms	435	59.43%
Phosphorus Forms	17	2.32%
Fecal Coliforms	3	0.41%
Arsenic	9	1.23%
Cadmium	7	0.96%
Chromium	45	6.15%
Copper	35	4.78%
Iron	10	1.37%
Lead	17	2.32%
Mercury	5	0.68%
Zinc	42	5.74%
Oil & Grease	155	21.17%
PCBs	1	0.14%
Chlorinated Hydrocarbons	5	0.68%

It is clear that beyond flow, BOD<sub>5</sub>, TSS, and Oil & Grease, the number of permits reporting data for other constituents such as metals and complex organics are extremely small. Even the nitrogen forms reported are mostly ammonia, and there is very little data for other nitrogen forms which could be used to determine total nitrogen. Consequently, to obtain a reasonable estimate of constituent loading to the Galveston Bay system, the use of TPCs (Typical Pollutant Concentrations) to estimate loadings had to be employed.

Using TPCs, however, limited the scope of the constituents for which loading estimates could be made to those used by Pacheco et al. (1990), namely those given in the table above. Beyond PCBs and chlorinated hydrocarbons, there are no other TPCs for complex organics, and the same is true for the metals. Thus, even though some dischargers do report the discharge of other metals than those listed above or specific organic compounds, the loads calculated for them will reflect only those dischargers for which loads have been reported.

Of the 224,066 potential discharge-days reported by permitted municipal and industrial dischargers, bypasses occurred on only 179 of those discharge-days (or less than 0.08 percent of the time). The greatest number of bypass-days were to Segment 1014 (101 bypass-days) and next was Segment 2424 with 42 bypass-days. The rest were scattered among Segments 0801 (7 bypass-days), 1001 (5 bypass-days), 1006 (7 bypass-days), 1007 (11 bypass-days), 1101 (4 bypass-days), 1104 (1 bypass-days), and 2421 (1 bypass-days).

#### **4.2.2 Statistical Analyses Of Constituent Concentrations**

Concentrations of constituents from dischargers were characterized by the following statistical parameters: distribution (normal or skewed), arithmetic means, medians, modes, standard deviations, variance, measures of skewness and kurtosis, range, minimum, and maximum. A file was created from the self-reporting data containing all the values reported for 30-day average BOD<sub>5</sub> concentrations. Overall statistics were calculated for the 4,740 BOD<sub>5</sub> concentrations contained therein. BOD<sub>5</sub> concentrations for 21 dischargers were chosen at random, and the twelve 30-day average BOD<sub>5</sub> concentrations reported during 1990 were examined for these statistical parameters. The results are given in Table 4.1. The distribution of all 4,740 BOD<sub>5</sub> values is skewed to the right as indicated by the skewness value of 6.32. This is expected as mostly small concentrations of BOD<sub>5</sub> are reported. The overall mean was 3.35 mg/L with a standard deviation of 4.07 mg/L, and the median was 2.45 mg/L. The low mean and median BOD<sub>5</sub> values demonstrate the very low effluent concentrations being achieved by the wastewater treatment plants in the Galveston Bay area. Examining the results for the 21 dischargers in Table 4.1 shows that most of the dischargers selected have means below 5 mg/L, and all means were below 10 mg/L.

For industrial wastewater dischargers, statistics for 30-day average BOD<sub>5</sub>, TSS,

**Table 4.1 - Summary of Statistics for Reported BOD<sub>5</sub> Concentrations in Selected Municipal Wastewater Discharges in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Statistic	Units	Discharger Permit No.										
		WQ0010208	WQ0011296	WQ0010668	WQ0010436	WQ0010794	WQ0011201	WQ0011739	WQ0012127	WQ0012292	WQ0012450	WQ0012414
Mean	mg/L	9.77	3.96	2.35	4.13	7.63	4.11	3.03	2.06	1.82	3.21	1.38
Standard Error of the Mean	mg/L	4.00	0.59	0.21	0.25	0.52	0.42	0.29	0.18	0.19	1.54	0.14
Median	mg/L	6.8	3.3	2.335	4.25	8	4.7	3.15	1.85	1.75	1.55	1.2
Mode	mg/L	-	2.0	1.5	-	5.0	-	-	1.7	2.0	1.5	1.2
Standard Deviation	mg/L	13.86	2.04	0.71	0.85	1.80	1.45	0.99	0.62	0.65	5.33	0.49
Variance	(mg/L) <sup>2</sup>	192.00	4.16	0.51	0.73	3.23	2.10	0.98	0.38	0.42	28.42	0.24
Kurtosis	-	10.77	-1.09	-1.57	-0.36	-1.31	-1.82	-0.17	8.34	1.64	11.48	0.29
Skewness	-	3.22	0.72	0.10	-0.43	-0.23	-0.26	0.46	2.74	1.02	3.36	1.35
Range	mg/L	50.35	5.2	2	2.9	5	3.8	3.44	2.3	2.33	19	1.4
Minimum	mg/L	2.52	2	1.5	2.5	5	2.1	1.56	1.6	1	1	1
Maximum	mg/L	52.87	7.2	3.5	5.4	10	5.9	5	3.9	3.33	20	2.4
Sum	mg/L	117.2	47.5	28.2	49.6	91.5	49.3	36.4	24.7	21.8	38.6	16.6
Count	No.	12	12	12	12	12	12	12	12	12	12	12
Largest (1)	mg/L	52.87	7.2	3.5	5.4	10	5.9	5	3.9	3.33	20	2.4
Smallest (1)	mg/L	2.52	2	1.5	2.5	5	2.1	1.56	1.6	1	1	1
Confidence Level (95%)	mg/L	7.840	1.153	0.403	0.483	1.017	0.820	0.561	0.351	0.367	3.016	0.276
Coefficient of Variation	-	1.42	0.51	0.30	0.21	0.24	0.35	0.33	0.30	0.36	1.66	0.35

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Statistic	Units	Discharger Permit No.										
		WQ0013319	WQ0010495	WQ0010495	WQ0010495	WQ0010570	WQ0012415	WQ0011273	WQ0012370	WQ0010688	WQ0010931	All Data
Mean	mg/L	3.80	3.50	2.58	2.17	2.00	3.46	5.29	3.33	2.70	9.25	3.35
Standard Error of the Mean	mg/L	0.60	0.23	0.51	0.11	0.28	0.41	0.43	0.89	0.23	2.23	0.06
Median	mg/L	2.8	3.5	3	2	1.75	3	5.05	1.815	2.46	6	2.45
Mode	mg/L	2.8	4.0	4.0	2.0	1.0	2.5	-	1.8	4.0	4.0	0.0
Standard Deviation	mg/L	2.07	0.80	1.78	0.39	0.97	1.43	1.48	3.08	0.81	7.72	4.07
Variance	(mg/L) <sup>2</sup>	4.27	0.64	3.17	0.15	0.95	2.05	2.20	9.46	0.66	59.66	16.53
Kurtosis	-	-0.46	0.15	-1.15	2.64	-1.26	0.48	-1.47	5.06	-1.04	3.08	64.74
Skewness	-	1.05	0.00	-0.51	2.06	0.43	1.18	0.20	2.20	0.51	1.70	6.32
Range	mg/L	6.1	3	5	1	2.75	4.6	4.1	10.5	2.37	26	65
Minimum	mg/L	1.5	2	0	2	1	1.7	3.3	1.25	1.63	3	0
Maximum	mg/L	7.6	5	5	3	3.75	6.3	7.4	11.75	4	29	65
Sum	mg/L	45.6	42.0	31.0	26.0	24.1	41.5	63.5	39.9	32.3	111.0	15,855.6
Count	No.	12	12	12	12	12	12	12	12	12	12	4,740
Largest (1)	mg/L	7.6	5	5	3	3.75	6.3	7.4	11.75	4	29	65
Smallest (1)	mg/L	1.5	2	0	2	1	1.7	3.3	1.25	1.63	3	0
Confidence Level (95%)	mg/L	1.169	0.451	1.008	0.220	0.552	0.810	0.839	1.740	0.460	4.370	0.116
Coefficient of Variation	-	0.54	0.23	0.69	0.18	0.49	0.41	0.28	0.92	0.30	0.84	1.22

and seven metals are given in Table 4.2. Again, files were created containing all reported concentrations of each constituent, and the statistics calculated for all values therein. For  $BOD_5$ , the mean and median concentrations were 4.3 mg/L and 2.4 mg/L, respectively, for the 420 values downloaded. The distribution for  $BOD_5$  is skewed to the right as it was for municipal dischargers, but not quite as strongly. The TSS mean concentration was essentially 8.0 mg/L, but was influenced strongly by some very high values. For the metals, only a few dischargers had to report them, and the concentrations reported are small. Arsenic from three dischargers averaged 0.055 mg/L, cadmium from four dischargers averaged zero, chromium from nine dischargers averaged 0.028 mg/L, copper from 18 dischargers averaged 0.009 mg/L, lead from seven dischargers averaged 0.025 mg/L, mercury from two dischargers averaged 0.0043 mg/L, and zinc from eleven dischargers averaged 0.099 mg/L. Except for lead, all of the averages are less than the new TPCs contained in Table 3.6, that is, the long term average concentrations allowable in effluents after third round permitting. Some dischargers have effluent concentrations exceeding these new TPCs as can be seen by comparing the largest concentrations listed in Table 4.2 with the new TPCs given in Table 3.6.

#### 4.2.3      Estimated Loads

Annual loading estimates of those constituents for which TPCs were available from Pacheco et al. (1990) are given in this section. Aggregated by Texas Water Quality Segments, these loading estimates are contained in a series of tables, one per constituent. The reader should keep in mind that these are loads based on a combination of self-reporting data and TPCs. Thus, these loading estimates do not represent the results of sampling of each constituent monitored in each discharger's effluent, and, for those load estimates made up substantially of estimates based on TPCs, the load estimates are accurate to the extent the TPCs are accurate. The implications of this assumption include estimates of loading that may be higher than actually occurred in 1990 because the TPCs are higher than concentrations actually found in effluents and higher because the NCPDI methodology, due to aggregation of SIC codes, assumed constituents were present in some industrial effluents when, in fact, they were not.

Over 1.311 trillion gallons of wastewater are discharged to the Galveston Bay system annually with the majority going into Segments 1006 and 1007 (Houston Ship channel), 2421 (Upper Galveston Bay), 2422 (Trinity Bay), 2425 (Clear Lake), and 2427 (San Jacinto Bay)(see Table 4.3). Much of this flow is cooling water contributed by Houston Lighting and Power generating stations with smaller amounts from other industries. Indeed, if the cooling water flows were removed from the flow estimates given in Table 4.3, the total would drop to 0.175 trillion gallons per year (Table 4.4) with most of the wastewater discharged into Segments 1006 and 1007 (Houston Ship Channel), and 1014 (Buffalo Bayou above Tidal). Of the 0.175 trillion gallons per year, about 23 percent is industrial process wastewater and the rest (about 77 percent) municipal wastewater.

$BOD_5$  loading amounted to over 4.6 million kg/yr with most of that going into the Houston Ship Channel/San Jacinto River area (Table 4.5). Of the total load, just

**Table 4.2 - Summary of Statistics for Reported Constituents in Industrial Wastewater Discharges in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Statistic	Units	BOD <sub>5</sub>	TSS	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Zinc
Mean		4.299	7.959	0.055	0.000	0.028	0.009	0.025	0.000	0.099
Standard Error of the Mean	mg/L	0.297	1.912	0.027	0.000	0.006	0.001	0.007	0.000	0.013
Median	mg/L	2.357	3.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
Mode	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Standard Deviation	mg/L	6.091	59.970	0.162	0.000	0.062	0.021	0.067	0.001	0.144
Variance	(mg/L) <sup>2</sup>	37.099	3,596,366	0.026	0.000	0.004	0.000	0.005	0.000	0.021
Kurtosis	-	9.917	928.082	17.070	-	11.983	27.590	8.353	0.177	3.381
Skewness	-	2.759	30.050	3.956	-	3.113	4.317	2.924	1.093	1.789
Range	mg/L	43.0	1,860.0	0.8	0.0	0.4	0.2	0.3	0.0	0.7
Minimum	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum	mg/L	43.0	1,860.0	0.8	0.0	0.4	0.2	0.3	0.0	0.7
Sum	mg/L	1,805.7	7,831.9	2.0	0.0	3.0	1.9	2.1	0.0	13.0
Count		420	984	36	48	108	216	84	24	132
Largest (1)	mg/L	43.0	1,860.0	0.8	0.0	0.4	0.2	0.3	0.0	0.7
Smallest (1)	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Confidence Level (95%)	mg/L	0.583	3.747	0.053	-	0.012	0.003	0.014	0.000	0.025
Coefficient of Variation	-	1.42	7.53	2.95	-	2.24	2.44	2.70	1.26	1.46

Based on 30-day average values

**Table 4.3 - Total Effluent Flow into Galveston Bay in 1990**

Point Source Load Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Actual Average Municipal Flow (MG/yr)	Total Flow (MG/yr)	Actual Average Industrial Flow (% of Total)	Actual Average Municipal Flow (% of Total)	Total Flow (% of Total)
0801	4.46	787.57	792.03	0.00%	0.58%	0.06%
0802	49.91	299.23	349.14	0.00%	0.22%	0.03%
0901	1,182.05	892.97	2,075.02	0.10%	0.66%	0.16%
0902	192.67	118.99	311.67	0.02%	0.09%	0.02%
1001	2,405.55	1,196.17	3,601.72	0.20%	0.89%	0.27%
1005	7,695.70	0.03	7,695.73	0.65%	0.00%	0.59%
1006	45,974.45	17,869.98	63,844.43	3.91%	13.25%	4.87%
1007	44,955.61	75,921.55	120,877.16	3.82%	56.29%	9.22%
1013	9.63	6,619.27	6,628.90	0.00%	4.91%	0.51%
1014	65.47	11,249.12	11,314.59	0.01%	8.34%	0.86%
1101	0.00	3,002.88	3,002.88	0.00%	2.23%	0.23%
1102	0.00	2,887.69	2,887.69	0.00%	2.14%	0.22%
1103	19.26	982.63	1,001.89	0.00%	0.73%	0.08%
1104	0.00	71.97	71.97	0.00%	0.05%	0.01%
1105	0.00	120.69	120.69	0.00%	0.09%	0.01%
1107	3,026.78	9.67	3,036.45	0.26%	0.01%	0.23%
1108	3.25	15.03	18.28	0.00%	0.01%	0.00%
1113	0.00	2,244.90	2,244.90	0.00%	1.66%	0.17%
2421	434,463.47	2,117.35	436,580.83	36.94%	1.57%	33.30%
2422	417,454.63	194.65	417,649.29	35.49%	0.14%	31.85%
2424	0.87	2,037.35	2,038.22	0.00%	1.51%	0.16%
2425	115,282.77	138.86	115,421.64	9.80%	0.10%	8.80%
2426	14.46	1,393.76	1,408.22	0.00%	1.03%	0.11%
2427	61,487.45	0.00	61,487.45	5.23%	0.00%	4.69%
2429	98.57	0.00	98.57	0.01%	0.00%	0.01%
2430	4.99	0.00	4.99	0.00%	0.00%	0.00%
2431	82.27	2,255.36	2,337.63	0.01%	1.67%	0.18%
2432	0.00	985.62	985.62	0.00%	0.73%	0.08%
2436	0.00	20.89	20.89	0.00%	0.02%	0.00%
2437	4,717.61	0.00	4,717.61	0.40%	0.00%	0.36%
2438	3,868.78	0.00	3,868.78	0.33%	0.00%	0.30%
2439	33,219.85	1,436.19	34,656.04	2.82%	1.06%	2.64%
Totals	1,176,280.51	134,870.34	1,311,150.85	100.00%	100.00%	100.00%
	89.71%	10.29%				

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included here

**Table 4.4 - Effluent Flows Without Cooling Water into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Actual Average Municipal Flow (MG/yr)	Total Flow (MG/yr)	Actual Average Industrial Flow (% of Total)	Actual Average Municipal Flow (% of Total)	Total Flow (% of Total)
0801	4.46	787.57	792.03	0.01%	0.58%	0.45%
0802	10.11	299.23	309.34	0.02%	0.22%	0.18%
0901	1,182.05	892.97	2,075.02	2.90%	0.66%	1.18%
0902	192.67	118.99	311.67	0.47%	0.09%	0.18%
1001	2,405.55	1,196.17	3,601.72	5.91%	0.89%	2.05%
1005	7,695.70	0.03	7,695.73	18.90%	0.00%	4.38%
1006	10,386.00	17,869.98	28,255.97	25.51%	13.25%	16.09%
1007	3,407.93	75,921.55	79,329.47	8.37%	56.29%	45.18%
1013	9.63	6,619.27	6,628.90	0.02%	4.91%	3.78%
1014	65.47	11,249.12	11,314.59	0.16%	8.34%	6.44%
1101	0.00	3,002.88	3,002.88	0.00%	2.23%	1.71%
1102	0.00	2,887.69	2,887.69	0.00%	2.14%	1.64%
1103	0.00	982.63	982.63	0.00%	0.73%	0.56%
1104	0.00	71.97	71.97	0.00%	0.05%	0.04%
1105	0.00	120.69	120.69	0.00%	0.09%	0.07%
1107	3,026.78	9.67	3,036.45	7.43%	0.01%	1.73%
1108	3.25	15.03	18.28	0.01%	0.01%	0.01%
1113	0.00	2,244.90	2,244.90	0.00%	1.66%	1.28%
2421	62.51	2,117.35	2,179.87	0.15%	1.57%	1.24%
2422	0.00	194.65	194.65	0.00%	0.14%	0.11%
2424	0.87	2,037.35	2,038.22	0.00%	1.51%	1.16%
2425	24.47	138.86	163.33	0.06%	0.10%	0.09%
2426	14.46	1,393.76	1,408.22	0.04%	1.03%	0.80%
2427	3,432.42	0.00	3,432.42	8.43%	0.00%	1.95%
2429	98.57	0.00	98.57	0.24%	0.00%	0.06%
2430	4.99	0.00	4.99	0.01%	0.00%	0.00%
2431	82.27	2,255.36	2,337.63	0.20%	1.67%	1.33%
2432	0.00	985.62	985.62	0.00%	0.73%	0.56%
2436	0.00	20.89	20.89	0.00%	0.02%	0.01%
2437	4,717.61	0.00	4,717.61	11.59%	0.00%	2.69%
2438	3,868.78	0.00	3,868.78	9.50%	0.00%	2.20%
2439	20.41	1,436.19	1,456.61	0.05%	1.06%	0.83%
Totals	40,716.96	134,870.34	175,587.30	100.00%	100.00%	100.00%
	23.19%	76.81%				

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included here

**Table 4.5 - Effluent Loads of BOD<sub>5</sub> into Galveston Bay**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	82	0	787.57	1,604	16,151	792.03	82	17,754	17,837
0802	49.91	156	0	299.23	0	18,469	349.14	156	18,469	18,625
0901	1,182.05	2,747	18,066	892.97	32	25,144	2,075.02	20,812	25,176	45,988
0902	192.67	0	5,053	118.99	0	1,482	311.67	5,053	1,482	6,535
1001	2,405.55	48	64,224	1,196.17	1,319	20,482	3,601.72	64,272	21,800	86,073
1005	7,695.70	2,839	631,020	0.03	0	0	7,695.73	633,859	0	633,859
1006	45,974.45	5,592	754,752	17,869.98	30,077	164,773	63,844.43	760,344	194,850	955,194
1007	44,955.61	2,051	863,870	75,921.55	17,347	621,124	120,877.16	865,922	638,471	1,504,392
1013	9.63	0	483	6,619.27	43,156	27,982	6,628.90	483	71,139	71,622
1014	65.47	2	1,532	11,249.12	40,397	60,655	11,314.59	1,534	101,051	102,585
1101	0.00	0	0	3,002.88	15,304	12,278	3,002.88	0	27,581	27,581
1102	0.00	0	0	2,887.69	568	32,896	2,887.69	0	33,464	33,464
1103	19.26	0	1,349	982.63	0	20,824	1,001.89	1,349	20,824	22,173
1104	0.00	0	0	71.97	0	594	71.97	0	594	594
1105	0.00	0	0	120.69	0	4,094	120.69	0	4,094	4,094
1107	3,026.78	0	106,024	9.67	0	278	3,036.45	106,024	278	106,302
1108	3.25	0	14	15.03	0	467	18.28	14	467	480
1113	0.00	0	0	2,244.90	0	17,838	2,244.90	0	17,838	17,838
2421	434,463.47	0	1,811	2,117.35	0	32,326	436,580.83	1,811	32,326	34,137
2422	417,454.63	0	0	194.65	0	2,714	417,649.29	0	2,714	2,714
2424	0.87	0	43	2,037.35	0	23,915	2,038.22	43	23,915	23,958
2425	115,282.77	451	0	138.86	0	915	115,421.64	451	915	1,367
2426	14.46	0	358	1,393.76	943	23,863	1,408.22	358	24,805	25,163
2427	61,487.45	501	56,847	0.00	0	0	61,487.45	57,348	0	57,348
2429	98.57	209	0	0.00	0	0	98.57	209	0	209
2430	4.99	0	330	0.00	0	0	4.99	330	0	330
2431	82.27	0	2,516	2,255.36	0	73,273	2,337.63	2,516	73,273	75,788
2432	0.00	0	0	985.62	0	15,148	985.62	0	15,148	15,148
2436	0.00	0	0	20.89	217	0	20.89	0	217	217
2437	4,717.61	0	452,954	0.00	0	0	4,717.61	452,954	0	452,954
2438	3,868.78	0	164,470	0.00	0	0	3,868.78	164,470	0	164,470
2439	33,219.85	0	118,597	1,436.19	0	26,917	34,656.04	118,597	26,917	145,514
Totals	1,176,280.51	14,679.08	3,244,312.77	134,870.34	150,962.48	1,244,599.50	1,311,150.85	3,258,991.85	1,395,561.98	4,654,553.82
	89.71%	0.45%	99.55%	10.29%	10.82%	89.18%		70.02%	29.98%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

over 70 percent is from industrial sources while 30 percent is from municipal. Because  $\text{BOD}_5$  is self-reported by essentially all dischargers, the proportion of the load estimated with TPCs is <1 percent for industrial dischargers and about 10 percent for municipal.

Total suspended solids follows a similar pattern to  $\text{BOD}_5$  as seen in Table 4.6. Just over 9.7 million kg/yr is estimated to be discharged to Galveston Bay, and 72.5 percent of this is from industrial dischargers and the balance from municipal. Like  $\text{BOD}_5$ , TSS is reported by most dischargers, and the portion of the industrial load estimated using TPCs is only about 1.5 percent. All of the municipal load is measured.

Some 6.28 million kg/yr of oil and grease reaches Galveston Bay via permitted wastewater discharges as shown in Table 4.7. Essentially all (91 percent) is from municipal dischargers and the balance from industrial. However, all of the municipal load is estimated using TPCs. There were no reported concentrations of oil and grease from municipalities against which to compare the TPC for oil and grease, and if the ratio of TPC-estimated to reported loads for municipal discharges is similar to that for industrial, the oil and grease load from municipal dischargers would be reduced by a factor of 7. Doing so would reduce the total load to just over 1 million kg/yr with roughly even distribution between municipal and industrial.

Total nitrogen is not reported by any of the municipal or industrial dischargers. Ammonia is reported by many (as part of nitrification requirements to lower oxygen demand in receiving waters due to ammonia and thus is small anyway), but so few other forms of nitrogen are reported that it is not possible to estimate total nitrogen loading from self-reporting data. As shown in Table 4.8, all of the total nitrogen loading is estimated using TPCs. For industrial discharges, the TPCs given in Pacheco et al. (1990) for total nitrogen were used, whereas the TPC for municipal discharges was thought to be low. Examination of effluent data for the City of Austin in the authors' files and the City of Houston (Jensen 1993) revealed that an effluent concentration of 14 mg/L was more appropriate than the value of 11.2 mg/L used by Pacheco et al. (1990). Using these TPCs, the total nitrogen load was estimated to be 8.4 million kg/yr with almost 85 percent coming from municipal dischargers and 15 percent from industrial.

As with nitrogen, total phosphorus forms were seldom reported; only a few industrial dischargers reported phosphorus and no municipal dischargers reported any. Consequently, the 4.0 million kg/yr estimated to be discharged to Galveston Bay (Table 4.9) is based almost entirely on TPC-estimated loading. Some 89 percent of what is discharged to the Bay comes from municipalities with the rest from industry.

Loads for total organic carbon and inorganic carbon were not estimated as Pacheco et al. (1990) listed no TPCs for these forms and relatively few dischargers reported these forms. The same was true for chemical oxygen demand (COD).

Fecal coliform bacteria discharges were estimated to be  $2.59 \times 10^{15}$  colonies/yr with just over 60 percent originating with industrial dischargers (Table 4.10).

**Table 4.6 - Effluent Loads of TSS into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	177	0	787.57	0	46,126	792.03	177	46,126	46,303
0802	49.91	610	0	299.23	0	72,875	349.14	610	72,875	73,485
0901	1,182.05	0	52,919	892.97	0	13,805	2,075.02	52,919	13,805	66,725
0902	192.67	0	14,025	118.99	0	3,078	311.67	14,025	3,078	17,102
1001	2,405.55	31,395	129,190	1,196.17	0	53,108	3,601.72	160,585	53,108	213,693
1005	7,695.70	13,707	862,584	0.03	0	68	7,695.73	876,291	68	876,359
1006	45,974.45	6,077	1,754,341	17,869.98	0	395,794	63,844.43	1,760,418	395,794	2,156,212
1007	44,955.61	11,135	2,125,062	75,921.55	0	1,406,311	120,877.16	2,136,196	1,406,311	3,542,507
1013	9.63	4	335	6,619.27	0	123,421	6,628.90	338	123,421	123,759
1014	65.47	20	3,155	11,249.12	0	187,008	11,314.59	3,176	187,008	190,184
1101	0.00	0	0	3,002.88	0	27,951	3,002.88	0	27,951	27,951
1102	0.00	0	0	2,887.69	0	35,820	2,887.69	0	35,820	35,820
1103	19.26	0	2,517	982.63	0	10,464	1,001.89	2,517	10,464	12,981
1104	0.00	0	0	71.97	0	1,630	71.97	0	1,630	1,630
1105	0.00	0	0	120.69	0	4,622	120.69	0	4,622	4,622
1107	3,026.78	0	339,057	9.67	0	426	3,036.45	339,057	426	339,483
1108	3.25	0	39	15.03	0	811	18.28	39	811	850
1113	0.00	0	0	2,244.90	0	17,840	2,244.90	0	17,840	17,840
2421	434,463.47	0	6,869	2,117.35	0	41,413	436,580.83	6,869	41,413	48,281
2422	417,454.63	0	0	194.65	0	5,145	417,649.29	0	5,145	5,145
2424	0.87	0	202	2,037.35	0	26,600	2,038.22	202	26,600	26,802
2425	115,282.77	0	748	138.86	0	1,989	115,421.64	748	1,989	2,737
2426	14.46	0	508	1,393.76	0	37,206	1,408.22	508	37,206	37,715
2427	61,487.45	35,184	199,292	0.00	0	0	61,487.45	234,476	0	234,476
2429	98.57	3,924	0	0.00	0	0	98.57	3,924	0	3,924
2430	4.99	0	721	0.00	0	0	4.99	721	0	721
2431	82.27	0	6,381	2,255.36	0	91,525	2,337.63	6,381	91,525	97,906
2432	0.00	0	0	985.62	0	37,364	985.62	0	37,364	37,364
2436	0.00	0	0	20.89	0	1,550	20.89	0	1,550	1,550
2437	4,717.61	49	845,522	0.00	0	0	4,717.61	845,571	0	845,571
2438	3,868.78	3	400,661	0.00	0	0	3,868.78	400,664	0	400,664
2439	33,219.85	0	190,684	1,436.19	0	23,419	34,656.04	190,684	23,419	214,103
Totals	1,176,280.51	102,285.52	6,934,811.35	134,870.34	0.00	2,667,367.00	1,311,150.85	7,037,096.87	2,667,367.00	9,704,463.87
	89.71%	1.45%	98.55%	10.29%	0.00%	100.00%		72.51%	27.49%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.7 - Effluent Loads of Oil and Grease into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0	136	787.57	33,369	0	792.03	136	33,369	33,505
0802	49.91	80	0	299.23	12,678	0	349.14	80	12,678	12,759
0901	1,182.05	259	3,368	892.97	37,835	0	2,075.02	3,627	37,835	41,462
0902	192.67	0	2,239	118.99	5,042	0	311.67	2,239	5,042	7,280
1001	2,405.55	4,280	17,994	1,196.17	50,681	0	3,601.72	22,274	50,681	72,956
1005	7,695.70	10,089	49,407	0.03	1	0	7,695.73	59,496	1	59,498
1006	45,974.45	34,854	23,108	17,869.98	757,149	0	63,844.43	57,962	757,149	815,110
1007	44,955.61	3,527	209,267	75,921.55	3,216,786	0	120,877.16	212,795	3,216,786	3,429,581
1013	9.63	6	71	6,619.27	280,458	0	6,628.90	77	280,458	280,535
1014	65.47	20	522	11,249.12	476,624	0	11,314.59	542	476,624	477,166
1101	0.00	0	0	3,002.88	127,232	0	3,002.88	0	127,232	127,232
1102	0.00	0	0	2,887.69	122,351	0	2,887.69	0	122,351	122,351
1103	19.26	0	6,491	982.63	41,634	0	1,001.89	6,491	41,634	48,125
1104	0.00	0	0	71.97	3,049	0	71.97	0	3,049	3,049
1105	0.00	0	0	120.69	5,113	0	120.69	0	5,113	5,113
1107	3,026.78	0	0	9.67	410	0	3,036.45	0	410	410
1108	3.25	0	9	15.03	637	0	18.28	9	637	645
1113	0.00	0	0	2,244.90	95,116	0	2,244.90	0	95,116	95,116
2421	434,463.47	0	2,401	2,117.35	89,712	0	436,580.83	2,401	89,712	92,113
2422	417,454.63	0	0	194.65	8,247	0	417,649.29	0	8,247	8,247
2424	0.87	0	34	2,037.35	86,322	0	2,038.22	34	86,322	86,356
2425	115,282.77	0	261	138.86	5,884	0	115,421.64	261	5,884	6,145
2426	14.46	0	123	1,393.76	59,053	0	1,408.22	123	59,053	59,176
2427	61,487.45	6,075	1,752	0.00	0	0	61,487.45	7,827	0	7,827
2429	98.57	585	0	0.00	0	0	98.57	585	0	585
2430	4.99	0	275	0.00	0	0	4.99	275	0	275
2431	82.27	488	0	2,255.36	95,559	0	2,337.63	488	95,559	96,047
2432	0.00	0	0	985.62	41,760	0	985.62	0	41,760	41,760
2436	0.00	0	0	20.89	885	0	20.89	0	885	885
2437	4,717.61	7	48,260	0.00	0	0	4,717.61	48,267	0	48,267
2438	3,868.78	0	80,130	0.00	0	0	3,868.78	80,130	0	80,130
2439	33,219.85	14	61,570	1,436.19	60,851	0	34,656.04	61,585	60,851	122,436
Totals	1,176,280.51	60,286.07	507,416.90	134,870.34	5,714,438.77	0.00	1,311,150.85	567,702.97	5,714,438.77	6,282,141.74
	89.71%	10.62%	89.38%	10.29%	100.00%	0.00%		9.04%	90.96%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.8 - Effluent Loads of Total Nitrogen into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	189	0	787.57	41,712	0	792.03	189	41,712	41,900
0802	49.91	0	0	299.23	15,848	0	349.14	0	15,848	15,848
0901	1,182.05	35,074	0	892.97	47,294	0	2,075.02	35,074	47,294	82,368
0902	192.67	24,345	0	118.99	6,302	0	311.67	24,345	6,302	30,647
1001	2,405.55	1,212	0	1,196.17	63,352	0	3,601.72	1,212	63,352	64,564
1005	7,695.70	436,952	0	0.03	1	0	7,695.73	436,952	1	436,953
1006	45,974.45	409,929	0	17,869.98	946,436	0	63,844.43	409,929	946,436	1,356,365
1007	44,955.61	50,881	0	75,921.55	4,020,982	0	120,877.16	50,881	4,020,982	4,071,864
1013	9.63	93	0	6,619.27	350,572	0	6,628.90	93	350,572	350,665
1014	65.47	244	0	11,249.12	595,779	0	11,314.59	244	595,779	596,023
1101	0.00	0	0	3,002.88	159,039	0	3,002.88	0	159,039	159,039
1102	0.00	0	0	2,887.69	152,939	0	2,887.69	0	152,939	152,939
1103	19.26	0	0	982.63	52,042	0	1,001.89	0	52,042	52,042
1104	0.00	0	0	71.97	3,811	0	71.97	0	3,811	3,811
1105	0.00	0	0	120.69	6,392	0	120.69	0	6,392	6,392
1107	3,026.78	0	0	9.67	512	0	3,036.45	0	512	512
1108	3.25	49	0	15.03	796	0	18.28	49	796	845
1113	0.00	0	0	2,244.90	118,895	0	2,244.90	0	118,895	118,895
2421	434,463.47	7,140	0	2,117.35	112,140	0	436,580.83	7,140	112,140	119,280
2422	417,454.63	0	0	194.65	10,309	0	417,649.29	0	10,309	10,309
2424	0.87	46	0	2,037.35	107,903	0	2,038.22	46	107,903	107,949
2425	115,282.77	1,037	0	138.86	7,355	0	115,421.64	1,037	7,355	8,391
2426	14.46	458	0	1,393.76	73,817	0	1,408.22	458	73,817	74,275
2427	61,487.45	67,025	0	0.00	0	0	61,487.45	67,025	0	67,025
2429	98.57	5,220	0	0.00	0	0	98.57	5,220	0	5,220
2430	4.99	211	0	0.00	0	0	4.99	211	0	211
2431	82.27	4,357	0	2,255.36	119,449	0	2,337.63	4,357	119,449	123,806
2432	0.00	0	0	985.62	52,201	0	985.62	0	52,201	52,201
2436	0.00	0	0	20.89	1,106	0	20.89	0	1,106	1,106
2437	4,717.61	237,832	0	0.00	0	0	4,717.61	237,832	0	237,832
2438	3,868.78	0	0	0.00	0	0	3,868.78	0	0	0
2439	33,219.85	129	0	1,436.19	76,064	0	34,656.04	129	76,064	76,193
Totals	1,176,280.51	1,282,425.05	0.00	134,870.34	7,143,048.46	0.00	1,311,150.85	1,282,425.05	7,143,048.46	8,425,473.51
	89.71%	100.00%	0.00%	10.29%	100.00%	0.00%		15.22%	84.78%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.9 - Effluent Loads of Total Phosphorus into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	118	0	787.57	20,856	0	792.03	118	20,856	20,974
0802	49.91	0	0	299.23	7,924	0	349.14	0	7,924	7,924
0901	1,182.05	5,566	0	892.97	23,647	0	2,075.02	5,566	23,647	29,213
0902	192.67	0	0	118.99	3,151	0	311.67	0	3,151	3,151
1001	2,405.55	606	0	1,196.17	31,676	0	3,601.72	606	31,676	32,282
1005	7,695.70	184,746	0	0.03	1	0	7,695.73	184,746	1	184,747
1006	45,974.45	14,952	0	17,869.98	473,218	0	63,844.43	14,952	473,218	488,170
1007	44,955.61	23,400	1,993	75,921.55	2,010,491	0	120,877.16	25,393	2,010,491	2,035,884
1013	9.63	52	0	6,619.27	175,286	0	6,628.90	52	175,286	175,338
1014	65.47	99	12	11,249.12	297,890	0	11,314.59	112	297,890	298,002
1101	0.00	0	0	3,002.88	79,520	0	3,002.88	0	79,520	79,520
1102	0.00	0	0	2,887.69	76,469	0	2,887.69	0	76,469	76,469
1103	19.26	0	0	982.63	26,021	0	1,001.89	0	26,021	26,021
1104	0.00	0	0	71.97	1,906	0	71.97	0	1,906	1,906
1105	0.00	0	0	120.69	3,196	0	120.69	0	3,196	3,196
1107	3,026.78	0	0	9.67	256	0	3,036.45	0	256	256
1108	3.25	30	0	15.03	398	0	18.28	30	398	428
1113	0.00	0	0	2,244.90	59,447	0	2,244.90	0	59,447	59,447
2421	434,463.47	4,463	0	2,117.35	56,070	0	436,580.83	4,463	56,070	60,533
2422	417,454.63	0	0	194.65	5,155	0	417,649.29	0	5,155	5,155
2424	0.87	23	0	2,037.35	53,951	0	2,038.22	23	53,951	53,974
2425	115,282.77	648	0	138.86	3,677	0	115,421.64	648	3,677	4,325
2426	14.46	287	0	1,393.76	36,908	0	1,408.22	287	36,908	37,195
2427	61,487.45	4,749	1,945	0.00	0	0	61,487.45	6,694	0	6,694
2429	98.57	2,610	0	0.00	0	0	98.57	2,610	0	2,610
2430	4.99	132	0	0.00	0	0	4.99	132	0	132
2431	82.27	2,179	0	2,255.36	59,724	0	2,337.63	2,179	59,724	61,903
2432	0.00	0	0	985.62	26,100	0	985.62	0	26,100	26,100
2436	0.00	0	0	20.89	553	0	20.89	0	553	553
2437	4,717.61	182,467	0	0.00	0	0	4,717.61	182,467	0	182,467
2438	3,868.78	0	0	0.00	0	0	3,868.78	0	0	0
2439	33,219.85	65	0	1,436.19	38,032	0	34,656.04	65	38,032	38,097
Totals	1,176,280.51	427,191.59	3,950.37	134,870.34	3,571,524.23	0.00	1,311,150.85	431,141.96	3,571,524.23	4,002,666.19
	89.71%	99.08%	0.92%	10.29%	100.00%	0.00%		10.77%	89.23%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.9 - Effluent Loads of Total Phosphorus into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

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Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	118	0	787.57	20,856	0	792.03	118	20,856	20,974
0802	49.91	0	0	299.23	7,924	0	349.14	0	7,924	7,924
0901	1,182.05	5,566	0	892.97	23,647	0	2,075.02	5,566	23,647	29,213
0902	192.67	0	0	118.99	3,151	0	311.67	0	3,151	3,151
1001	2,405.55	606	0	1,196.17	31,676	0	3,601.72	606	31,676	32,282
1005	7,695.70	184,746	0	0.03	1	0	7,695.73	184,746	1	184,747
1006	45,974.45	14,952	0	17,869.98	473,218	0	63,844.43	14,952	473,218	488,170
1007	44,955.61	23,400	1,993	75,921.55	2,010,491	0	120,877.16	25,393	2,010,491	2,035,884
1013	9.63	52	0	6,619.27	175,286	0	6,628.90	52	175,286	175,338
1014	65.47	99	12	11,249.12	297,890	0	11,314.59	112	297,890	298,002
1101	0.00	0	0	3,002.88	79,520	0	3,002.88	0	79,520	79,520
1102	0.00	0	0	2,887.69	76,469	0	2,887.69	0	76,469	76,469
1103	19.26	0	0	982.63	26,021	0	1,001.89	0	26,021	26,021
1104	0.00	0	0	71.97	1,906	0	71.97	0	1,906	1,906
1105	0.00	0	0	120.69	3,196	0	120.69	0	3,196	3,196
1107	3,026.78	0	0	9.67	256	0	3,036.45	0	256	256
1108	3.25	30	0	15.03	398	0	18.28	30	398	428
1113	0.00	0	0	2,244.90	59,447	0	2,244.90	0	59,447	59,447
2421	434,463.47	4,463	0	2,117.35	56,070	0	436,580.83	4,463	56,070	60,533
2422	417,454.63	0	0	194.65	5,155	0	417,649.29	0	5,155	5,155
2424	0.87	23	0	2,037.35	53,951	0	2,038.22	23	53,951	53,974
2425	115,282.77	648	0	138.86	3,677	0	115,421.64	648	3,677	4,325
2426	14.46	287	0	1,393.76	36,908	0	1,408.22	287	36,908	37,195
2427	61,487.45	4,749	1,945	0.00	0	0	61,487.45	6,694	0	6,694
2429	98.57	2,610	0	0.00	0	0	98.57	2,610	0	2,610
2430	4.99	132	0	0.00	0	0	4.99	132	0	132
2431	82.27	2,179	0	2,255.36	59,724	0	2,337.63	2,179	59,724	61,903
2432	0.00	0	0	985.62	26,100	0	985.62	0	26,100	26,100
2436	0.00	0	0	20.89	553	0	20.89	0	553	553
2437	4,717.61	182,467	0	0.00	0	0	4,717.61	182,467	0	182,467
2438	3,868.78	0	0	0.00	0	0	3,868.78	0	0	0
2439	33,219.85	65	0	1,436.19	38,032	0	34,656.04	65	38,032	38,097
Totals	1,176,280.51	427,191.59	3,950.37	134,870.34	3,571,524.23	0.00	1,311,150.85	431,141.96	3,571,524.23	4,002,666.19
	89.71%	99.08%	0.92%	10.29%	100.00%	0.00%		10.77%	89.23%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.10- Effluent Loads of Fecal Coliforms into Galveston Bay in 1990**

Point Source Load Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (10 <sup>9</sup> col./yr)	Measured Industrial Load (10 <sup>9</sup> col./yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (10 <sup>9</sup> col./yr)	Measured Municipal Load (10 <sup>9</sup> col./yr)	Total Flow (MG/yr)	Total Industrial Load (10 <sup>9</sup> col./yr)	Total Municipal Load (10 <sup>9</sup> col./yr)	Total Load (10 <sup>9</sup> col./yr)
0801	0.0	33.7	0.0	0.8	5,961.9	0.0	0.8	33.7	5,961.9	5,995.7
0802	0.0	0.0	0.0	0.3	2,265.2	0.0	0.3	0.0	2,265.2	2,265.2
0901	1.2	1,591.2	0.0	0.9	6,759.8	0.0	2.1	1,591.2	6,759.8	8,351.0
0902	0.2	0.0	0.0	0.1	900.8	0.0	0.3	0.0	900.8	900.8
1001	2.4	173.3	0.0	1.2	9,055.0	0.0	3.6	173.3	9,055.0	9,228.3
1005	7.7	52,812.1	0.0	0.0	0.2	0.0	7.7	52,812.1	0.2	52,812.3
1006	46.0	4,231.3	0.0	17.9	135,275.7	0.0	63.8	4,231.3	135,275.7	139,507.0
1007	45.0	7,100.7	1,456,261.5	75.9	574,726.1	0.0	120.9	1,463,362.2	574,726.1	2,038,088.3
1013	0.0	14.7	0.0	6.6	50,107.9	0.0	6.6	14.7	50,107.9	50,122.6
1014	0.1	23.6	0.0	11.2	85,155.8	0.0	11.3	23.6	85,155.8	85,179.4
1101	0.0	0.0	0.0	3.0	22,731.8	0.0	3.0	0.0	22,731.8	22,731.8
1102	0.0	0.0	0.0	2.9	21,859.8	0.0	2.9	0.0	21,859.8	21,859.8
1103	0.0	0.0	0.0	1.0	7,438.5	0.0	1.0	0.0	7,438.5	7,438.5
1104	0.0	0.0	0.0	0.1	544.8	0.0	0.1	0.0	544.8	544.8
1105	0.0	0.0	0.0	0.1	913.6	0.0	0.1	0.0	913.6	913.6
1107	3.0	0.0	0.0	0.0	73.2	0.0	3.0	0.0	73.2	73.2
1108	0.0	8.7	0.0	0.0	113.8	0.0	0.0	8.7	113.8	122.5
1113	0.0	0.0	0.0	2.2	16,993.9	0.0	2.2	0.0	16,993.9	16,993.9
2421	434.5	1,275.7	0.0	2.1	16,028.4	0.0	436.6	1,275.7	16,028.4	17,304.1
2422	417.5	0.0	0.0	0.2	1,473.5	0.0	417.6	0.0	1,473.5	1,473.5
2424	0.0	6.6	0.0	2.0	15,422.7	0.0	2.0	6.6	15,422.7	15,429.3
2425	115.3	185.2	0.0	0.1	1,051.2	0.0	115.4	185.2	1,051.2	1,236.4
2426	0.0	81.9	0.0	1.4	10,550.7	0.0	1.4	81.9	10,550.7	10,632.6
2427	61.5	1,357.6	0.0	0.0	0.0	0.0	61.5	1,357.6	0.0	1,357.6
2429	0.1	746.2	0.0	0.0	0.0	0.0	0.1	746.2	0.0	746.2
2430	0.0	37.8	0.0	0.0	0.0	0.0	0.0	37.8	0.0	37.8
2431	0.1	622.8	0.0	2.3	17,073.1	0.0	2.3	622.8	17,073.1	17,695.8
2432	0.0	0.0	0.0	1.0	7,461.1	0.0	1.0	0.0	7,461.1	7,461.1
2436	0.0	0.0	0.0	0.0	158.1	0.0	0.0	0.0	158.1	158.1
2437	4.7	28,106.0	0.0	0.0	0.0	0.0	4.7	28,106.0	0.0	28,106.0
2438	3.9	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0
2439	33.2	0.0	15,466.0	1.4	10,872.0	0.0	34.7	15,466.0	10,872.0	26,338.0
Totals	1,176.3	98,409.1	1,471,727.5	134.9	1,020,968.5	0.0	1,311.2	1,570,136.6	1,020,968.5	2,591,105.1
	89.71%	6.27%	93.73%	10.29%	100.00%	0.00%		60.60%	39.40%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

Essentially all of this load is based on TPCs with the exception of a few industries required to monitor fecal coliform bacteria. This distribution between municipal and industrial is skewed because of one industrial discharger with a large emission during one month to water quality segment 1007. Without that discharge, the municipal discharges would have dominated.

Estimated discharges of metals to Galveston Bay relied heavily on TPCs. No municipalities reported any metal loadings, and the number of industrial dischargers reported metal loads varied with the metal. Arsenic, for example, was estimated to be discharged to the Bay in the amount of 20,123 kg/yr with essentially all of the load determined from TPCs (Table 4.11). Only a small portion of the industrial load was from monitoring data. Municipal dischargers were estimated to account for over 81 percent of the total arsenic reaching the Bay. The same applies to cadmium (Table 4.12) with 6,397 kg/yr; about 88 percent of the load was estimated to be from municipal dischargers. Chromium is monitored and reported by more industrial dischargers, and 74 percent of the industrial load is based on measured concentrations but amounts to less than one-fourth of the total estimated load of 32,167 kg/yr (Table 4.13). Essentially all the copper load to Galveston Bay, estimated to be 27,960 kg/yr (see Table 4.14), is based on TPCs, and most of it is discharged to Houston Ship Channel segments. Loadings of iron are given in Table 4.15, and total 422,791 kg/yr, mostly (almost 85 percent) from municipal dischargers; Houston Ship Channel segments are again the recipients for most of this load. The estimated load of lead to Galveston Bay is 25,368 kg/yr with most being discharged to the Houston Ship Channel segments (Table 4.16); over 90 percent of the lead is calculated to come from municipal discharges. Mercury is estimated to reach the Houston Ship Channel in Segments 1006 and 1007 primarily; the total load to Galveston Bay is calculated to be 220.7 kg/yr with over half of that being discharged to these two segments (Table 4.17) and by municipal dischargers. Because essentially all of the mercury being discharged to Segments 1006 and 1007 is based on a TPC, the load needs to be used with caution. Some 114,024 kg/yr of zinc are estimated to reach Galveston Bay again mainly in the Houston Ship Channel segments with almost 75 percent of this load determined to originate with municipal dischargers and most of it based on TPCs (Table 4.18).

PCBs reaching Galveston Bay are estimated to be 15.7 kg/yr with all of that load coming from a permitted industrial effluent in Segment 1006 (Table 4.19). The only TPC for PCB is for the Power Transformers industry, but, since PCBs have been banned from production, that TPC should now be zero. Since no loads were calculated based on a TPC, no industry of this type discharges to Galveston Bay.

Following the calculation of loads for the above constituents, the load of metals were recalculated assuming that round-three permitting was complete. As described in Chapter 3, round-three permitting will result in effluent limits being set for those dischargers having metal concentrations high enough to cause potential violations of receiving water standards. Long term average concentrations for these metals determined by following the procedure described in Chapter 3 are given in Table 3.6, and any TPC exceeding those values (allowing for the ratio reduction in the TPC also) would be reduced to the long term averages. All of the metals described above (except iron because there is no surface water quality standard for iron) were

**Table 4.11 - Effluent Loads of Total Arsenic into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.43	0.00	787.57	95.34	0.00	792.03	0.43	95.34	95.77
0802	49.91	0.00	0.00	299.23	36.22	0.00	349.14	0.00	36.22	36.22
0901	1,182.05	41.73	0.00	892.97	108.10	0.00	2,075.02	41.73	108.10	149.83
0902	192.67	17.49	0.00	118.99	14.41	0.00	311.67	17.49	14.41	31.90
1001	2,405.55	122.46	0.00	1,196.17	144.80	0.00	3,601.72	122.46	144.80	267.27
1005	7,695.70	724.12	0.00	0.03	0.00	0.00	7,695.73	724.12	0.00	724.12
1006	45,974.45	1,073.53	2.25	17,869.98	2,163.28	0.00	63,844.43	1,075.78	2,163.28	3,239.07
1007	44,955.61	246.65	0.00	75,921.55	9,190.82	0.00	120,877.16	246.65	9,190.82	9,437.47
1013	9.63	1.33	0.00	6,619.27	801.31	0.00	6,628.90	1.33	801.31	802.64
1014	65.47	11.59	0.00	11,249.12	1,361.78	0.00	11,314.59	11.59	1,361.78	1,373.38
1101	0.00	0.00	0.00	3,002.88	363.52	0.00	3,002.88	0.00	363.52	363.52
1102	0.00	0.00	0.00	2,887.69	349.57	0.00	2,887.69	0.00	349.57	349.57
1103	19.26	0.00	0.00	982.63	118.95	0.00	1,001.89	0.00	118.95	118.95
1104	0.00	0.00	0.00	71.97	8.71	0.00	71.97	0.00	8.71	8.71
1105	0.00	0.00	0.00	120.69	14.61	0.00	120.69	0.00	14.61	14.61
1107	3,026.78	0.00	0.00	9.67	1.17	0.00	3,036.45	0.00	1.17	1.17
1108	3.25	0.01	0.00	15.03	1.82	0.00	18.28	0.01	1.82	1.83
1113	0.00	0.00	0.00	2,244.90	271.76	0.00	2,244.90	0.00	271.76	271.76
2421	434,463.47	29.56	0.00	2,117.35	256.32	0.00	436,580.83	29.56	256.32	285.88
2422	417,454.63	0.00	0.00	194.65	23.56	0.00	417,649.29	0.00	23.56	23.56
2424	0.87	0.08	0.00	2,037.35	246.64	0.00	2,038.22	0.08	246.64	246.72
2425	115,282.77	2.37	0.00	138.86	16.81	0.00	115,421.64	2.37	16.81	19.18
2426	14.46	1.82	0.00	1,393.76	168.72	0.00	1,408.22	1.82	168.72	170.54
2427	61,487.45	298.81	0.00	0.00	0.00	0.00	61,487.45	298.81	0.00	298.81
2429	98.57	9.55	0.00	0.00	0.00	0.00	98.57	9.55	0.00	9.55
2430	4.99	0.48	0.00	0.00	0.00	0.00	4.99	0.48	0.00	0.48
2431	82.27	7.97	0.00	2,255.36	273.03	0.00	2,337.63	7.97	273.03	280.99
2432	0.00	0.00	0.00	985.62	119.32	0.00	985.62	0.00	119.32	119.32
2436	0.00	0.00	0.00	20.89	2.53	0.00	20.89	0.00	2.53	2.53
2437	4,717.61	381.71	0.00	0.00	0.00	0.00	4,717.61	381.71	0.00	381.71
2438	3,868.78	819.59	0.00	0.00	0.00	0.00	3,868.78	819.59	0.00	819.59
2439	33,219.85	0.24	2.46	1,436.19	173.86	0.00	34,656.04	2.70	173.86	176.56
Totals	1,176,280.51	3,791.53	4.71	134,870.34	16,326.97	0.00	1,311,150.85	3,796.24	16,326.97	20,123.21
	89.71%	99.88%	0.12%	10.29%	100.00%	0.00%		18.86%	81.14%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.12 - Effluent Loads of Total Cadmium into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.09	0.00	787.57	32.77	0.00	792.03	0.09	32.77	32.86
0802	49.91	0.00	0.00	299.23	12.45	0.00	349.14	0.00	12.45	12.45
0901	1,182.05	4.99	0.00	892.97	37.16	0.00	2,075.02	4.99	37.16	42.15
0902	192.67	1.04	0.00	118.99	4.95	0.00	311.67	1.04	4.95	5.99
1001	2,405.55	9.61	0.00	1,196.17	49.78	0.00	3,601.72	9.61	49.78	59.39
1005	7,695.70	140.46	0.00	0.03	0.00	0.00	7,695.73	140.46	0.00	140.46
1006	45,974.45	83.83	0.00	17,869.98	743.63	0.00	63,844.43	83.83	743.63	827.46
1007	44,955.61	43.69	10.16	75,921.55	3,159.34	0.00	120,877.16	53.85	3,159.34	3,213.20
1013	9.63	0.46	0.00	6,619.27	275.45	0.00	6,628.90	0.46	275.45	275.90
1014	65.47	1.68	0.00	11,249.12	468.11	0.00	11,314.59	1.68	468.11	469.79
1101	0.00	0.00	0.00	3,002.88	124.96	0.00	3,002.88	0.00	124.96	124.96
1102	0.00	0.00	0.00	2,887.69	120.17	0.00	2,887.69	0.00	120.17	120.17
1103	19.26	0.00	0.00	982.63	40.89	0.00	1,001.89	0.00	40.89	40.89
1104	0.00	0.00	0.00	71.97	2.99	0.00	71.97	0.00	2.99	2.99
1105	0.00	0.00	0.00	120.69	5.02	0.00	120.69	0.00	5.02	5.02
1107	3,026.78	0.00	0.00	9.67	0.40	0.00	3,036.45	0.00	0.40	0.40
1108	3.25	0.00	0.00	15.03	0.63	0.00	18.28	0.00	0.63	0.63
1113	0.00	0.00	0.00	2,244.90	93.42	0.00	2,244.90	0.00	93.42	93.42
2421	434,463.47	4.33	0.00	2,117.35	88.11	0.00	436,580.83	4.33	88.11	92.44
2422	417,454.63	0.00	0.00	194.65	8.10	0.00	417,649.29	0.00	8.10	8.10
2424	0.87	0.02	0.00	2,037.35	84.78	0.00	2,038.22	0.02	84.78	84.80
2425	115,282.77	0.48	0.00	138.86	5.78	0.00	115,421.64	0.48	5.78	6.26
2426	14.46	0.27	0.00	1,393.76	58.00	0.00	1,408.22	0.27	58.00	58.27
2427	61,487.45	58.86	0.00	0.00	0.00	0.00	61,487.45	58.86	0.00	58.86
2429	98.57	1.94	0.00	0.00	0.00	0.00	98.57	1.94	0.00	1.94
2430	4.99	0.10	0.00	0.00	0.00	0.00	4.99	0.10	0.00	0.10
2431	82.27	1.62	0.00	2,255.36	93.85	0.00	2,337.63	1.62	93.85	95.48
2432	0.00	0.00	0.00	985.62	41.01	0.00	985.62	0.00	41.01	41.01
2436	0.00	0.00	0.00	20.89	0.87	0.00	20.89	0.00	0.87	0.87
2437	4,717.61	358.95	0.00	0.00	0.00	0.00	4,717.61	358.95	0.00	358.95
2438	3,868.78	62.43	0.00	0.00	0.00	0.00	3,868.78	62.43	0.00	62.43
2439	33,219.85	0.05	0.00	1,436.19	59.76	0.00	34,656.04	0.05	59.76	59.81
Totals	1,176,280.51	774.89	10.16	134,870.34	5,612.40	0.00	1,311,150.85	785.06	5,612.40	6,397.45
	89.71%	98.71%	1.29%	10.29%	100.00%	0.00%		12.27%	87.73%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.13 - Effluent Loads of Total Chromium into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.27	0.00	787.57	128.11	0.00	792.03	0.27	128.11	128.38
0802	49.91	0.00	0.00	299.23	48.68	0.00	349.14	0.00	48.68	48.68
0901	1,182.05	215.50	1.47	892.97	145.26	0.00	2,075.02	216.97	145.26	362.23
0902	192.67	188.97	0.00	118.99	19.36	0.00	311.67	188.97	19.36	208.33
1001	2,405.55	4.74	457.63	1,196.17	194.58	0.00	3,601.72	462.37	194.58	656.95
1005	7,695.70	581.56	1,886.68	0.03	0.00	0.00	7,695.73	2,468.24	0.00	2,468.25
1006	45,974.45	239.65	1,526.68	17,869.98	2,906.91	0.00	63,844.43	1,766.33	2,906.91	4,673.24
1007	44,955.61	108.36	2,868.37	75,921.55	12,350.16	0.00	120,877.16	2,976.74	12,350.16	15,326.90
1013	9.63	1.32	1.13	6,619.27	1,076.76	0.00	6,628.90	2.45	1,076.76	1,079.21
1014	65.47	12.05	0.00	11,249.12	1,829.89	0.00	11,314.59	12.05	1,829.89	1,841.94
1101	0.00	0.00	0.00	3,002.88	488.48	0.00	3,002.88	0.00	488.48	488.48
1102	0.00	0.00	0.00	2,887.69	469.74	0.00	2,887.69	0.00	469.74	469.74
1103	19.26	0.00	0.00	982.63	159.84	0.00	1,001.89	0.00	159.84	159.84
1104	0.00	0.00	0.00	71.97	11.71	0.00	71.97	0.00	11.71	11.71
1105	0.00	0.00	0.00	120.69	19.63	0.00	120.69	0.00	19.63	19.63
1107	3,026.78	0.00	100.86	9.67	1.57	0.00	3,036.45	100.86	1.57	102.43
1108	3.25	0.06	0.00	15.03	2.45	0.00	18.28	0.06	2.45	2.51
1113	0.00	0.00	0.00	2,244.90	365.18	0.00	2,244.90	0.00	365.18	365.18
2421	434,463.47	15.41	0.00	2,117.35	344.43	0.00	436,580.83	15.41	344.43	359.84
2422	417,454.63	0.00	0.00	194.65	31.66	0.00	417,649.29	0.00	31.66	31.66
2424	0.87	0.05	0.00	2,037.35	331.42	0.00	2,038.22	0.05	331.42	331.47
2425	115,282.77	1.47	0.00	138.86	22.59	0.00	115,421.64	1.47	22.59	24.06
2426	14.46	0.96	0.00	1,393.76	226.72	0.00	1,408.22	0.96	226.72	227.68
2427	61,487.45	78.50	236.65	0.00	0.00	0.00	61,487.45	315.15	0.00	315.15
2429	98.57	5.94	0.00	0.00	0.00	0.00	98.57	5.94	0.00	5.94
2430	4.99	0.30	0.00	0.00	0.00	0.00	4.99	0.30	0.00	0.30
2431	82.27	4.96	0.00	2,255.36	366.88	0.00	2,337.63	4.96	366.88	371.84
2432	0.00	0.00	0.00	985.62	160.33	0.00	985.62	0.00	160.33	160.33
2436	0.00	0.00	0.00	20.89	3.40	0.00	20.89	0.00	3.40	3.40
2437	4,717.61	1,215.85	268.69	0.00	0.00	0.00	4,717.61	1,484.54	0.00	1,484.54
2438	3,868.78	0.00	121.34	0.00	0.00	0.00	3,868.78	121.34	0.00	121.34
2439	33,219.85	0.15	81.99	1,436.19	233.63	0.00	34,656.04	82.13	233.63	315.76
Totals	1,176,280.51	2,676.05	7,551.50	134,870.34	21,939.36	0.00	1,311,150.85	10,227.55	21,939.36	32,166.91
	89.71%	26.17%	73.83%	10.29%	100.00%	0.00%		31.80%	68.20%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.14 - Effluent Loads of Total Copper into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.41	0.00	787.57	110.24	0.00	792.03	0.41	110.24	110.65
0802	49.91	0.20	0.00	299.23	41.88	0.00	349.14	0.20	41.88	42.08
0901	1,182.05	79.85	0.00	892.97	124.99	0.00	2,075.02	79.85	124.99	204.85
0902	192.67	47.95	0.00	118.99	16.66	0.00	311.67	47.95	16.66	64.61
1001	2,405.55	133.77	0.00	1,196.17	167.43	0.00	3,601.72	133.77	167.43	301.20
1005	7,695.70	775.39	150.41	0.03	0.00	0.00	7,695.73	925.80	0.00	925.80
1006	45,974.45	1,526.76	88.62	17,869.98	2,443.64	12.52	63,844.43	1,615.38	2,456.16	4,071.54
1007	44,955.61	465.58	82.24	75,921.55	10,626.88	0.00	120,877.16	547.82	10,626.88	11,174.70
1013	9.63	5.26	0.00	6,619.27	926.51	0.00	6,628.90	5.26	926.51	931.77
1014	65.47	16.13	0.00	11,249.12	1,574.56	0.00	11,314.59	16.13	1,574.56	1,590.69
1101	0.00	0.00	0.00	3,002.88	420.32	0.00	3,002.88	0.00	420.32	420.32
1102	0.00	0.00	0.00	2,887.69	404.20	0.00	2,887.69	0.00	404.20	404.20
1103	19.26	0.00	2.79	982.63	137.54	0.00	1,001.89	2.79	137.54	140.33
1104	0.00	0.00	0.00	71.97	10.07	0.00	71.97	0.00	10.07	10.07
1105	0.00	0.00	0.00	120.69	16.89	0.00	120.69	0.00	16.89	16.89
1107	3,026.78	7.53	0.00	9.67	1.35	0.00	3,036.45	7.53	1.35	8.89
1108	3.25	0.12	0.00	15.03	2.10	0.00	18.28	0.12	2.10	2.22
1113	0.00	0.00	0.00	2,244.90	314.22	0.00	2,244.90	0.00	314.22	314.22
2421	434,463.47	14.00	1.56	2,117.35	296.37	0.00	436,580.83	15.56	296.37	311.93
2422	417,454.63	2,077.93	0.00	194.65	27.25	0.00	417,649.29	2,077.93	27.25	2,105.18
2424	0.87	0.08	0.00	2,037.35	285.17	0.00	2,038.22	0.08	285.17	285.25
2425	115,282.77	575.97	0.00	138.86	19.44	0.00	115,421.64	575.97	19.44	595.40
2426	14.46	1.81	0.00	1,393.76	195.09	0.00	1,408.22	1.81	195.09	196.90
2427	61,487.45	614.56	1.91	0.00	0.00	0.00	61,487.45	616.47	0.00	616.47
2429	98.57	9.08	0.00	0.00	0.00	0.00	98.57	9.08	0.00	9.08
2430	4.99	0.46	0.00	0.00	0.00	0.00	4.99	0.46	0.00	0.46
2431	82.27	7.58	0.00	2,255.36	315.69	0.00	2,337.63	7.58	315.69	323.26
2432	0.00	0.00	0.00	985.62	137.96	0.00	985.62	0.00	137.96	137.96
2436	0.00	0.00	0.00	20.89	2.92	0.00	20.89	0.00	2.92	2.92
2437	4,717.61	2,092.50	0.00	0.00	0.00	0.00	4,717.61	2,092.50	0.00	2,092.50
2438	3,868.78	0.00	164.31	0.00	0.00	0.00	3,868.78	164.31	0.00	164.31
2439	33,219.85	165.21	17.44	1,436.19	201.03	0.00	34,656.04	182.65	201.03	383.67
Totals	1,176,280.51	8,618.13	509.28	134,870.34	18,820.40	12.52	1,311,150.85	9,127.41	18,832.93	27,960.34
	89.71%	94.42%	5.58%	10.29%	99.93%	0.07%		32.64%	67.36%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.15 - Effluent Loads of Total Iron into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	5.59	0.00	787.57	2,085.58	0.00	792.03	5.59	2,085.58	2,091.17
0802	49.91	0.00	0.00	299.23	792.39	0.00	349.14	0.00	792.39	792.39
0901	1,182.05	306.82	0.00	892.97	2,364.69	0.00	2,075.02	306.82	2,364.69	2,671.51
0902	192.67	0.00	0.00	118.99	315.11	0.00	311.67	0.00	315.11	315.11
1001	2,405.55	842.86	0.00	1,196.17	3,167.59	0.00	3,601.72	842.86	3,167.59	4,010.45
1005	7,695.70	8,755.73	0.00	0.03	0.07	0.00	7,695.73	8,755.73	0.07	8,755.80
1006	45,974.45	4,540.83	3.04	17,869.98	47,321.79	0.00	63,844.43	4,543.87	47,321.79	51,865.66
1007	44,955.61	1,966.04	0.00	75,921.55	201,049.12	0.00	120,877.16	1,966.04	201,049.12	203,015.16
1013	9.63	10.74	0.00	6,619.27	17,528.61	0.00	6,628.90	10.74	17,528.61	17,539.35
1014	65.47	78.72	13.40	11,249.12	29,788.97	0.00	11,314.59	92.12	29,788.97	29,881.09
1101	0.00	0.00	0.00	3,002.88	7,951.97	0.00	3,002.88	0.00	7,951.97	7,951.97
1102	0.00	0.00	0.00	2,887.69	7,646.93	0.00	2,887.69	0.00	7,646.93	7,646.93
1103	19.26	0.00	0.00	982.63	2,602.12	0.00	1,001.89	0.00	2,602.12	2,602.12
1104	0.00	0.00	0.00	71.97	190.57	0.00	71.97	0.00	190.57	190.57
1105	0.00	0.00	0.00	120.69	319.59	0.00	120.69	0.00	319.59	319.59
1107	3,026.78	0.00	0.00	9.67	25.60	0.00	3,036.45	0.00	25.60	25.60
1108	3.25	1.44	0.00	15.03	39.80	0.00	18.28	1.44	39.80	41.24
1113	0.00	0.00	0.00	2,244.90	5,944.75	0.00	2,244.90	0.00	5,944.75	5,944.75
2421	434,463.47	89.67	12.68	2,117.35	5,607.00	0.00	436,580.83	102.35	5,607.00	5,709.35
2422	417,454.63	0.00	0.00	194.65	515.47	0.00	417,649.29	0.00	515.47	515.47
2424	0.87	1.09	0.00	2,037.35	5,395.14	0.00	2,038.22	1.09	5,395.14	5,396.23
2425	115,282.77	30.71	0.00	138.86	367.73	0.00	115,421.64	30.71	367.73	398.43
2426	14.46	18.81	0.00	1,393.76	3,690.83	0.00	1,408.22	18.81	3,690.83	3,709.63
2427	61,487.45	1,292.78	0.00	0.00	0.00	0.00	61,487.45	1,292.78	0.00	1,292.78
2429	98.57	123.71	0.00	0.00	0.00	0.00	98.57	123.71	0.00	123.71
2430	4.99	6.26	0.00	0.00	0.00	0.00	4.99	6.26	0.00	6.26
2431	82.27	103.25	0.00	2,255.36	5,972.45	0.00	2,337.63	103.25	5,972.45	6,075.70
2432	0.00	0.00	0.00	985.62	2,610.03	0.00	985.62	0.00	2,610.03	2,610.03
2436	0.00	0.00	0.00	20.89	55.31	0.00	20.89	0.00	55.31	55.31
2437	4,717.61	41,882.56	0.00	0.00	0.00	0.00	4,717.61	41,882.56	0.00	41,882.56
2438	3,868.78	5,549.01	0.00	0.00	0.00	0.00	3,868.78	5,549.01	0.00	5,549.01
2439	33,219.85	3.06	0.00	1,436.19	3,803.21	0.00	34,656.04	3.06	3,803.21	3,806.27
Totals	1,176,280.51	65,609.67	29.13	134,870.34	357,152.42	0.00	1,311,150.85	65,638.79	357,152.42	422,791.22
	89.71%	99.96%	0.04%	10.29%	100.00%	0.00%		15.53%	84.47%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.16 - Effluent Loads of Total Lead into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.33	0.00	787.57	134.07	0.00	792.03	0.33	134.07	134.41
0802	49.91	0.00	0.00	299.23	50.94	0.00	349.14	0.00	50.94	50.94
0901	1,182.05	25.53	0.94	892.97	152.02	0.00	2,075.02	26.47	152.02	178.48
0902	192.67	9.59	0.00	118.99	20.26	0.00	311.67	9.59	20.26	29.85
1001	2,405.55	11.13	0.00	1,196.17	203.63	0.00	3,601.72	11.13	203.63	214.76
1005	7,695.70	547.48	0.00	0.03	0.00	0.00	7,695.73	547.48	0.00	547.48
1006	45,974.45	201.37	289.82	17,869.98	3,042.12	0.00	63,844.43	491.19	3,042.12	3,533.30
1007	44,955.61	206.70	44.87	75,921.55	12,924.59	0.00	120,877.16	251.57	12,924.59	13,176.16
1013	9.63	0.88	0.00	6,619.27	1,126.84	0.00	6,628.90	0.88	1,126.84	1,127.72
1014	65.47	2.44	0.00	11,249.12	1,915.01	0.00	11,314.59	2.44	1,915.01	1,917.45
1101	0.00	0.00	0.00	3,002.88	511.20	0.00	3,002.88	0.00	511.20	511.20
1102	0.00	0.00	0.00	2,887.69	491.59	0.00	2,887.69	0.00	491.59	491.59
1103	19.26	0.00	0.00	982.63	167.28	0.00	1,001.89	0.00	167.28	167.28
1104	0.00	0.00	0.00	71.97	12.25	0.00	71.97	0.00	12.25	12.25
1105	0.00	0.00	0.00	120.69	20.55	0.00	120.69	0.00	20.55	20.55
1107	3,026.78	0.00	0.00	9.67	1.65	0.00	3,036.45	0.00	1.65	1.65
1108	3.25	0.10	0.00	15.03	2.56	0.00	18.28	0.10	2.56	2.65
1113	0.00	0.00	0.00	2,244.90	382.16	0.00	2,244.90	0.00	382.16	382.16
2421	434,463.47	13.62	0.00	2,117.35	360.45	0.00	436,580.83	13.62	360.45	374.07
2422	417,454.63	0.00	0.00	194.65	33.14	0.00	417,649.29	0.00	33.14	33.14
2424	0.87	0.06	0.00	2,037.35	346.83	0.00	2,038.22	0.06	346.83	346.90
2425	115,282.77	1.83	0.00	138.86	23.64	0.00	115,421.64	1.83	23.64	25.47
2426	14.46	0.87	0.00	1,393.76	237.27	0.00	1,408.22	0.87	237.27	238.14
2427	61,487.45	269.40	3.83	0.00	0.00	0.00	61,487.45	273.24	0.00	273.24
2429	98.57	7.36	0.00	0.00	0.00	0.00	98.57	7.36	0.00	7.36
2430	4.99	0.37	0.00	0.00	0.00	0.00	4.99	0.37	0.00	0.37
2431	82.27	6.14	0.00	2,255.36	383.94	0.00	2,337.63	6.14	383.94	390.09
2432	0.00	0.00	0.00	985.62	167.79	0.00	985.62	0.00	167.79	167.79
2436	0.00	0.00	0.00	20.89	3.56	0.00	20.89	0.00	3.56	3.56
2437	4,717.61	722.33	0.00	0.00	0.00	0.00	4,717.61	722.33	0.00	722.33
2438	3,868.78	0.00	40.83	0.00	0.00	0.00	3,868.78	40.83	0.00	40.83
2439	33,219.85	0.18	0.00	1,436.19	244.49	0.00	34,656.04	0.18	244.49	244.67
Totals	1,176,280.51	2,027.71	380.29	134,870.34	22,959.80	0.00	1,311,150.85	2,408.00	22,959.80	25,367.80
	89.71%	84.21%	15.79%	10.29%	100.00%	0.00%		9.49%	90.51%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.17 - Effluent Loads of Total Mercury into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.00	0.00	787.57	0.89	0.00	792.03	0.00	0.89	0.90
0802	49.91	0.00	0.00	299.23	0.34	0.00	349.14	0.00	0.34	0.34
0901	1,182.05	1.50	0.00	892.97	1.01	0.00	2,075.02	1.50	1.01	2.52
0902	192.67	1.24	0.00	118.99	0.14	0.00	311.67	1.24	0.14	1.38
1001	2,405.55	1.23	0.00	1,196.17	1.36	0.00	3,601.72	1.23	1.36	2.59
1005	7,695.70	7.20	0.00	0.03	0.00	0.00	7,695.73	7.20	0.00	7.20
1006	45,974.45	28.05	2.11	17,869.98	20.28	0.00	63,844.43	30.17	20.28	50.45
1007	44,955.61	2.76	0.00	75,921.55	86.16	0.00	120,877.16	2.76	86.16	88.93
1013	9.63	0.01	0.00	6,619.27	7.51	0.00	6,628.90	0.01	7.51	7.53
1014	65.47	0.11	0.00	11,249.12	12.77	0.00	11,314.59	0.11	12.77	12.88
1101	0.00	0.00	0.00	3,002.88	3.41	0.00	3,002.88	0.00	3.41	3.41
1102	0.00	0.00	0.00	2,887.69	3.28	0.00	2,887.69	0.00	3.28	3.28
1103	19.26	0.00	0.00	982.63	1.12	0.00	1,001.89	0.00	1.12	1.12
1104	0.00	0.00	0.00	71.97	0.08	0.00	71.97	0.00	0.08	0.08
1105	0.00	0.00	0.00	120.69	0.14	0.00	120.69	0.00	0.14	0.14
1107	3,026.78	0.00	0.00	9.67	0.01	0.00	3,036.45	0.00	0.01	0.01
1108	3.25	0.00	0.00	15.03	0.02	0.00	18.28	0.00	0.02	0.02
1113	0.00	0.00	0.00	2,244.90	2.55	0.00	2,244.90	0.00	2.55	2.55
2421	434,463.47	0.23	0.00	2,117.35	2.40	0.00	436,580.83	0.23	2.40	2.63
2422	417,454.63	0.00	0.00	194.65	0.22	0.00	417,649.29	0.00	0.22	0.22
2424	0.87	0.00	0.00	2,037.35	2.31	0.00	2,038.22	0.00	2.31	2.31
2425	115,282.77	0.01	0.00	138.86	0.16	0.00	115,421.64	0.01	0.16	0.17
2426	14.46	0.01	0.00	1,393.76	1.58	0.00	1,408.22	0.01	1.58	1.60
2427	61,487.45	6.74	0.00	0.00	0.00	0.00	61,487.45	6.74	0.00	6.74
2429	98.57	0.05	0.00	0.00	0.00	0.00	98.57	0.05	0.00	0.05
2430	4.99	0.00	0.00	0.00	0.00	0.00	4.99	0.00	0.00	0.00
2431	82.27	0.04	0.00	2,255.36	2.56	0.00	2,337.63	0.04	2.56	2.60
2432	0.00	0.00	0.00	985.62	1.12	0.00	985.62	0.00	1.12	1.12
2436	0.00	0.00	0.00	20.89	0.02	0.00	20.89	0.00	0.02	0.02
2437	4,717.61	6.28	0.00	0.00	0.00	0.00	4,717.61	6.28	0.00	6.28
2438	3,868.78	0.00	10.03	0.00	0.00	0.00	3,868.78	10.03	0.00	10.03
2439	33,219.85	0.00	0.00	1,436.19	1.63	0.00	34,656.04	0.00	1.63	1.63
Totals	1,176,280.51	55.49	12.15	134,870.34	153.07	0.00	1,311,150.85	67.64	153.07	220.70
	89.71%	82.04%	17.96%	10.29%	100.00%	0.00%		30.65%	69.35%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.18 - Effluent Loads of Total Zinc into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	1.32	0.00	787.57	491.60	0.00	792.03	1.32	491.60	492.92
0802	49.91	0.00	0.00	299.23	186.78	0.00	349.14	0.00	186.78	186.78
0901	1,182.05	200.60	1.76	892.97	557.39	0.00	2,075.02	202.36	557.39	759.75
0902	192.67	103.63	0.00	118.99	74.28	0.00	311.67	103.63	74.28	177.91
1001	2,405.55	60.70	2,280.07	1,196.17	746.65	0.00	3,601.72	2,340.77	746.65	3,087.41
1005	7,695.70	2,003.12	283.38	0.03	0.02	0.00	7,695.73	2,286.50	0.02	2,286.52
1006	45,974.45	6,521.87	299.99	17,869.98	10,897.32	54.30	63,844.43	6,821.86	10,951.62	17,773.47
1007	44,955.61	1,072.85	7,739.81	75,921.55	47,390.15	0.00	120,877.16	8,812.66	47,390.15	56,202.81
1013	9.63	7.72	3.40	6,619.27	4,131.74	0.00	6,628.90	11.13	4,131.74	4,142.87
1014	65.47	101.09	1.46	11,249.12	7,021.69	0.00	11,314.59	102.55	7,021.69	7,124.23
1101	0.00	0.00	0.00	3,002.88	1,874.39	0.00	3,002.88	0.00	1,874.39	1,874.39
1102	0.00	0.00	0.00	2,887.69	1,802.49	0.00	2,887.69	0.00	1,802.49	1,802.49
1103	19.26	0.00	26.55	982.63	613.36	0.00	1,001.89	26.55	613.36	639.91
1104	0.00	0.00	0.00	71.97	44.92	0.00	71.97	0.00	44.92	44.92
1105	0.00	0.00	0.00	120.69	75.33	0.00	120.69	0.00	75.33	75.33
1107	3,026.78	0.00	189.04	9.67	6.03	0.00	3,036.45	189.04	6.03	195.07
1108	3.25	0.21	0.00	15.03	9.38	0.00	18.28	0.21	9.38	9.59
1113	0.00	0.00	0.00	2,244.90	1,401.26	0.00	2,244.90	0.00	1,401.26	1,401.26
2421	434,463.47	128.31	0.00	2,117.35	1,321.65	0.00	436,580.83	128.31	1,321.65	1,449.96
2422	417,454.63	0.00	0.00	194.65	121.50	0.00	417,649.29	0.00	121.50	121.50
2424	0.87	0.26	0.00	2,037.35	1,271.71	0.00	2,038.22	0.26	1,271.71	1,271.97
2425	115,282.77	7.24	0.00	138.86	86.68	0.00	115,421.64	7.24	86.68	93.92
2426	14.46	7.77	0.00	1,393.76	869.98	0.00	1,408.22	7.77	869.98	877.75
2427	61,487.45	1,177.47	732.97	0.00	0.00	0.00	61,487.45	1,910.44	0.00	1,910.44
2429	98.57	29.16	0.00	0.00	0.00	0.00	98.57	29.16	0.00	29.16
2430	4.99	1.48	0.00	0.00	0.00	0.00	4.99	1.48	0.00	1.48
2431	82.27	24.34	0.00	2,255.36	1,407.79	0.00	2,337.63	24.34	1,407.79	1,432.13
2432	0.00	0.00	0.00	985.62	615.22	0.00	985.62	0.00	615.22	615.22
2436	0.00	0.00	0.00	20.89	13.04	0.00	20.89	0.00	13.04	13.04
2437	4,717.61	5,837.03	186.28	0.00	0.00	0.00	4,717.61	6,023.31	0.00	6,023.31
2438	3,868.78	0.00	976.83	0.00	0.00	0.00	3,868.78	976.83	0.00	976.83
2439	33,219.85	0.72	32.55	1,436.19	896.47	0.00	34,656.04	33.27	896.47	929.74
Totals	1,176,280.51	17,286.89	12,754.09	134,870.34	83,928.82	54.30	1,311,150.85	30,040.97	83,983.12	114,024.09
	89.71%	57.54%	42.46%	10.29%	99.94%	0.06%		26.35%	73.65%	

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Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.19 - Effluent Loads of PCB into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.00	0.00	787.57	0.00	0.00	792.03	0.00	0.00	0.00
0802	49.91	0.00	0.00	299.23	0.00	0.00	349.14	0.00	0.00	0.00
0901	1,182.05	0.00	0.00	892.97	0.00	0.00	2,075.02	0.00	0.00	0.00
0902	192.67	0.00	0.00	118.99	0.00	0.00	311.67	0.00	0.00	0.00
1001	2,405.55	0.00	0.00	1,196.17	0.00	0.00	3,601.72	0.00	0.00	0.00
1005	7,695.70	0.00	0.00	0.03	0.00	0.00	7,695.73	0.00	0.00	0.00
1006	45,974.45	0.00	15.69	17,869.98	0.00	0.00	63,844.43	15.69	0.00	15.69
1007	44,955.61	0.00	0.00	75,921.55	0.00	0.00	120,877.16	0.00	0.00	0.00
1013	9.63	0.00	0.00	6,619.27	0.00	0.00	6,628.90	0.00	0.00	0.00
1014	65.47	0.00	0.00	11,249.12	0.00	0.00	11,314.59	0.00	0.00	0.00
1101	0.00	0.00	0.00	3,002.88	0.00	0.00	3,002.88	0.00	0.00	0.00
1102	0.00	0.00	0.00	2,887.69	0.00	0.00	2,887.69	0.00	0.00	0.00
1103	19.26	0.00	0.00	982.63	0.00	0.00	1,001.89	0.00	0.00	0.00
1104	0.00	0.00	0.00	71.97	0.00	0.00	71.97	0.00	0.00	0.00
1105	0.00	0.00	0.00	120.69	0.00	0.00	120.69	0.00	0.00	0.00
1107	3,026.78	0.00	0.00	9.67	0.00	0.00	3,036.45	0.00	0.00	0.00
1108	3.25	0.00	0.00	15.03	0.00	0.00	18.28	0.00	0.00	0.00
1113	0.00	0.00	0.00	2,244.90	0.00	0.00	2,244.90	0.00	0.00	0.00
2421	434,463.47	0.00	0.00	2,117.35	0.00	0.00	436,580.83	0.00	0.00	0.00
2422	417,454.63	0.00	0.00	194.65	0.00	0.00	417,649.29	0.00	0.00	0.00
2424	0.87	0.00	0.00	2,037.35	0.00	0.00	2,038.22	0.00	0.00	0.00
2425	115,282.77	0.00	0.00	138.86	0.00	0.00	115,421.64	0.00	0.00	0.00
2426	14.46	0.00	0.00	1,393.76	0.00	0.00	1,408.22	0.00	0.00	0.00
2427	61,487.45	0.00	0.00	0.00	0.00	0.00	61,487.45	0.00	0.00	0.00
2429	98.57	0.00	0.00	0.00	0.00	0.00	98.57	0.00	0.00	0.00
2430	4.99	0.00	0.00	0.00	0.00	0.00	4.99	0.00	0.00	0.00
2431	82.27	0.00	0.00	2,255.36	0.00	0.00	2,337.63	0.00	0.00	0.00
2432	0.00	0.00	0.00	985.62	0.00	0.00	985.62	0.00	0.00	0.00
2436	0.00	0.00	0.00	20.89	0.00	0.00	20.89	0.00	0.00	0.00
2437	4,717.61	0.00	0.00	0.00	0.00	0.00	4,717.61	0.00	0.00	0.00
2438	3,868.78	0.00	0.00	0.00	0.00	0.00	3,868.78	0.00	0.00	0.00
2439	33,219.85	0.00	0.00	1,436.19	0.00	0.00	34,656.04	0.00	0.00	0.00
Totals	1,176,280.51	0.00	15.69	134,870.34	0.00	0.00	1,311,150.85	15.69	0.00	15.69
	89.71%	0.00%	100.00%	10.29%	-	-		100.00%	0.00%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

recalculated and the results are given in Tables 4.20 through 4.26. The only metals for which the loads from permitted dischargers changed were copper (10 percent drop), mercury (4 percent), and zinc (3.5 percent drop). This suggests that the addition of effluent limitations for those metals considered here will change the loading from the permitted dischargers only slightly overall; local impact reductions could be significant and will require additional investigation.

Table 4.27 contains a summary of the estimated 1990 effluent loads using unmodified TPCs of those constituents mentioned above, the percent of the estimated loads based on measured concentrations and on TPCs, and the percent load contributions from industrial and municipal sources as determined in this study. In addition, the measured and estimated loads found by Pacheco et al. (1990) are included for comparison. All of the flow estimates in this study are based on self-reporting data, and essentially all of the BOD<sub>5</sub> and TSS loads are based on self-reporting data. However, for all other constituents, less than 25 percent the load for each is based on measured data. Agreement with Pacheco et al. (1990) on the proportions of the total load that is based on measured vs. TPC estimates is good except for BOD and TSS; there is much more reliance here on measured BOD and TSS loads.

Priority pollutant loadings, other than that for PCB, were calculated based on self-reporting data; thus, these loads do not include any TPC-based estimates as there are no TPCs available for priority pollutants at this time. Tabulations by water quality segment are not given herein, but the totals calculated are given below grouped by Priority Pollutant structural compounds. Loadings for the Phenols and Substituted Phenols are reported primarily as total phenols although several other forms are permitted. Some 2,800 kg/yr of total phenols are discharged to the Bay, primarily into the Houston Ship Channel. Only two Organonitrogen Compounds had loading data, and the amounts reported discharged totaled 29 kg/yr into Segment 901. Minimal amounts of the Low and High Molecular Weight Polynuclear Aromatic Hydrocarbons (PAH) were reported. Of the Chlorinated Aromatic Hydrocarbons, only chlorobenzene and 1,2-dichlorobenzene were reported to be discharged into Segment 901. No Chlorinated Aliphatic Hydrocarbons, Halogenated Ethers, Phthalates, nor Miscellaneous Oxygenated Compounds were reported discharged. No specific Pesticides were reported as discharged, but total chlorinated hydrocarbons amounted to over 1,800 kg/yr into Segments 902, 1005, and 1006. Generally small amounts (less than 20 kg/yr) of the Volatile Halogenated Alkanes and Alkenes were released, and these were into the Houston Ship Channel and Cedar Bayou. Toluene was the major Volatile Aromatic Hydrocarbon discharged, and it amounted to almost 37 kg/yr mostly into Segments 901 and 1107. Benzene was also released into Segment 1107. No Volatile Chlorinated Aromatic Hydrocarbons, Volatile Unsaturated Carbonyl Compounds, nor Volatile Ethers were reported as discharged. Several Miscellaneous compounds were also reported discharged.

No loads were estimated for salinity, conductivity, total dissolved solids, dissolved oxygen, and thermal wastes because so few dischargers were required to report these parameters and no TPCs existed for them. Total chlorine residual load was not calculated because only 18 dischargers were required to report it. Chlorine

**Table 4.20 - Effluent Loads of Total Arsenic into Galveston Bay in 1990 With Revised Typical Pollutant Concentrations**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.43	0.00	787.57	95.34	0.00	792.03	0.43	95.34	95.77
0802	49.91	0.00	0.00	299.23	36.22	0.00	349.14	0.00	36.22	36.22
0901	1,182.05	41.73	0.00	892.97	108.10	0.00	2,075.02	41.73	108.10	149.83
0902	192.67	17.49	0.00	118.99	14.41	0.00	311.67	17.49	14.41	31.90
1001	2,405.55	122.46	0.00	1,196.17	144.80	0.00	3,601.72	122.46	144.80	267.27
1005	7,695.70	724.12	0.00	0.03	0.00	0.00	7,695.73	724.12	0.00	724.12
1006	45,974.45	1,073.53	2.25	17,869.98	2,163.28	0.00	63,844.43	1,075.78	2,163.28	3,239.07
1007	44,955.61	246.65	0.00	75,921.55	9,190.82	0.00	120,877.16	246.65	9,190.82	9,437.47
1013	9.63	1.33	0.00	6,619.27	801.31	0.00	6,628.90	1.33	801.31	802.64
1014	65.47	11.59	0.00	11,249.12	1,361.78	0.00	11,314.59	11.59	1,361.78	1,373.38
1101	0.00	0.00	0.00	3,002.88	363.52	0.00	3,002.88	0.00	363.52	363.52
1102	0.00	0.00	0.00	2,887.69	349.57	0.00	2,887.69	0.00	349.57	349.57
1103	19.26	0.00	0.00	982.63	118.95	0.00	1,001.89	0.00	118.95	118.95
1104	0.00	0.00	0.00	71.97	8.71	0.00	71.97	0.00	8.71	8.71
1105	0.00	0.00	0.00	120.69	14.61	0.00	120.69	0.00	14.61	14.61
1107	3,026.78	0.00	0.00	9.67	1.17	0.00	3,036.45	0.00	1.17	1.17
1108	3.25	0.01	0.00	15.03	1.82	0.00	18.28	0.01	1.82	1.83
1113	0.00	0.00	0.00	2,244.90	271.76	0.00	2,244.90	0.00	271.76	271.76
2421	434,463.47	29.56	0.00	2,117.35	256.32	0.00	436,580.83	29.56	256.32	285.88
2422	417,454.63	0.00	0.00	194.65	23.56	0.00	417,649.29	0.00	23.56	23.56
2424	0.87	0.08	0.00	2,037.35	246.64	0.00	2,038.22	0.08	246.64	246.72
2425	115,282.77	2.37	0.00	138.86	16.81	0.00	115,421.64	2.37	16.81	19.18
2426	14.46	1.82	0.00	1,393.76	168.72	0.00	1,408.22	1.82	168.72	170.54
2427	61,487.45	298.81	0.00	0.00	0.00	0.00	61,487.45	298.81	0.00	298.81
2429	98.57	9.55	0.00	0.00	0.00	0.00	98.57	9.55	0.00	9.55
2430	4.99	0.48	0.00	0.00	0.00	0.00	4.99	0.48	0.00	0.48
2431	82.27	7.97	0.00	2,255.36	273.03	0.00	2,337.63	7.97	273.03	280.99
2432	0.00	0.00	0.00	985.62	119.32	0.00	985.62	0.00	119.32	119.32
2436	0.00	0.00	0.00	20.89	2.53	0.00	20.89	0.00	2.53	2.53
2437	4,717.61	381.71	0.00	0.00	0.00	0.00	4,717.61	381.71	0.00	381.71
2438	3,868.78	819.59	0.00	0.00	0.00	0.00	3,868.78	819.59	0.00	819.59
2439	33,219.85	0.24	2.46	1,436.19	173.86	0.00	34,656.04	2.70	173.86	176.56
Totals	1,176,280.51	3,791.53	4.71	134,870.34	16,326.97	0.00	1,311,150.85	3,796.24	16,326.97	20,123.21
	89.71%	99.88%	0.12%	10.29%	100.00%	0.00%		18.86%	81.14%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.21 - Effluent Loads of Total Cadmium into Galveston Bay in 1990 With Revised Typical Pollutant Concentrations**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.09	0.00	787.57	32.77	0.00	792.03	0.09	32.77	32.86
0802	49.91	0.00	0.00	299.23	12.45	0.00	349.14	0.00	12.45	12.45
0901	1,182.05	4.99	0.00	892.97	37.16	0.00	2,075.02	4.99	37.16	42.15
0902	192.67	1.04	0.00	118.99	4.95	0.00	311.67	1.04	4.95	5.99
1001	2,405.55	9.61	0.00	1,196.17	49.78	0.00	3,601.72	9.61	49.78	59.39
1005	7,695.70	140.46	0.00	0.03	0.00	0.00	7,695.73	140.46	0.00	140.46
1006	45,974.45	83.83	0.00	17,869.98	743.63	0.00	63,844.43	83.83	743.63	827.46
1007	44,955.61	43.69	10.16	75,921.55	3,159.34	0.00	120,877.16	53.85	3,159.34	3,213.20
1013	9.63	0.46	0.00	6,619.27	275.45	0.00	6,628.90	0.46	275.45	275.90
1014	65.47	1.68	0.00	11,249.12	468.11	0.00	11,314.59	1.68	468.11	469.79
1101	0.00	0.00	0.00	3,002.88	124.96	0.00	3,002.88	0.00	124.96	124.96
1102	0.00	0.00	0.00	2,887.69	120.17	0.00	2,887.69	0.00	120.17	120.17
1103	19.26	0.00	0.00	982.63	40.89	0.00	1,001.89	0.00	40.89	40.89
1104	0.00	0.00	0.00	71.97	2.99	0.00	71.97	0.00	2.99	2.99
1105	0.00	0.00	0.00	120.69	5.02	0.00	120.69	0.00	5.02	5.02
1107	3,026.78	0.00	0.00	9.67	0.40	0.00	3,036.45	0.00	0.40	0.40
1108	3.25	0.00	0.00	15.03	0.63	0.00	18.28	0.00	0.63	0.63
1113	0.00	0.00	0.00	2,244.90	93.42	0.00	2,244.90	0.00	93.42	93.42
2421	434,463.47	4.33	0.00	2,117.35	88.11	0.00	436,580.83	4.33	88.11	92.44
2422	417,454.63	0.00	0.00	194.65	8.10	0.00	417,649.29	0.00	8.10	8.10
2424	0.87	0.02	0.00	2,037.35	84.78	0.00	2,038.22	0.02	84.78	84.80
2425	115,282.77	0.48	0.00	138.86	5.78	0.00	115,421.64	0.48	5.78	6.26
2426	14.46	0.27	0.00	1,393.76	58.00	0.00	1,408.22	0.27	58.00	58.27
2427	61,487.45	58.86	0.00	0.00	0.00	0.00	61,487.45	58.86	0.00	58.86
2429	98.57	1.94	0.00	0.00	0.00	0.00	98.57	1.94	0.00	1.94
2430	4.99	0.10	0.00	0.00	0.00	0.00	4.99	0.10	0.00	0.10
2431	82.27	1.62	0.00	2,255.36	93.85	0.00	2,337.63	1.62	93.85	95.48
2432	0.00	0.00	0.00	985.62	41.01	0.00	985.62	0.00	41.01	41.01
2436	0.00	0.00	0.00	20.89	0.87	0.00	20.89	0.00	0.87	0.87
2437	4,717.61	358.95	0.00	0.00	0.00	0.00	4,717.61	358.95	0.00	358.95
2438	3,868.78	62.43	0.00	0.00	0.00	0.00	3,868.78	62.43	0.00	62.43
2439	33,219.85	0.05	0.00	1,436.19	59.76	0.00	34,656.04	0.05	59.76	59.81
Totals	1,176,280.51	774.89	10.16	134,870.34	5,612.40	0.00	1,311,150.85	785.06	5,612.40	6,397.45
	89.71%	98.71%	1.29%	10.29%	100.00%	0.00%		12.27%	87.73%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.22 - Effluent Loads of Total Chromium into Galveston Bay in 1990 With Revised Typical Pollutant Concentrations**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.27	0.00	787.57	128.11	0.00	792.03	0.27	128.11	128.38
0802	49.91	0.00	0.00	299.23	48.68	0.00	349.14	0.00	48.68	48.68
0901	1,182.05	215.50	1.47	892.97	145.26	0.00	2,075.02	216.97	145.26	362.23
0902	192.67	188.97	0.00	118.99	19.36	0.00	311.67	188.97	19.36	208.33
1001	2,405.55	4.74	457.63	1,196.17	194.58	0.00	3,601.72	462.37	194.58	656.95
1005	7,695.70	581.56	1,886.68	0.03	0.00	0.00	7,695.73	2,468.24	0.00	2,468.25
1006	45,974.45	239.65	1,526.68	17,869.98	2,906.91	0.00	63,844.43	1,766.33	2,906.91	4,673.24
1007	44,955.61	108.36	2,868.37	75,921.55	12,350.16	0.00	120,877.16	2,976.74	12,350.16	15,326.90
1013	9.63	1.32	1.13	6,619.27	1,076.76	0.00	6,628.90	2.45	1,076.76	1,079.21
1014	65.47	12.05	0.00	11,249.12	1,829.89	0.00	11,314.59	12.05	1,829.89	1,841.94
1101	0.00	0.00	0.00	3,002.88	488.48	0.00	3,002.88	0.00	488.48	488.48
1102	0.00	0.00	0.00	2,887.69	469.74	0.00	2,887.69	0.00	469.74	469.74
1103	19.26	0.00	0.00	982.63	159.84	0.00	1,001.89	0.00	159.84	159.84
1104	0.00	0.00	0.00	71.97	11.71	0.00	71.97	0.00	11.71	11.71
1105	0.00	0.00	0.00	120.69	19.63	0.00	120.69	0.00	19.63	19.63
1107	3,026.78	0.00	100.86	9.67	1.57	0.00	3,036.45	100.86	1.57	102.43
1108	3.25	0.06	0.00	15.03	2.45	0.00	18.28	0.06	2.45	2.51
1113	0.00	0.00	0.00	2,244.90	365.18	0.00	2,244.90	0.00	365.18	365.18
2421	434,463.47	15.41	0.00	2,117.35	344.43	0.00	436,580.83	15.41	344.43	359.84
2422	417,454.63	0.00	0.00	194.65	31.66	0.00	417,649.29	0.00	31.66	31.66
2424	0.87	0.05	0.00	2,037.35	331.42	0.00	2,038.22	0.05	331.42	331.47
2425	115,282.77	1.47	0.00	138.86	22.59	0.00	115,421.64	1.47	22.59	24.06
2426	14.46	0.96	0.00	1,393.76	226.72	0.00	1,408.22	0.96	226.72	227.68
2427	61,487.45	78.50	236.65	0.00	0.00	0.00	61,487.45	315.15	0.00	315.15
2429	98.57	5.94	0.00	0.00	0.00	0.00	98.57	5.94	0.00	5.94
2430	4.99	0.30	0.00	0.00	0.00	0.00	4.99	0.30	0.00	0.30
2431	82.27	4.96	0.00	2,255.36	366.88	0.00	2,337.63	4.96	366.88	371.84
2432	0.00	0.00	0.00	985.62	160.33	0.00	985.62	0.00	160.33	160.33
2436	0.00	0.00	0.00	20.89	3.40	0.00	20.89	0.00	3.40	3.40
2437	4,717.61	1,215.85	268.69	0.00	0.00	0.00	4,717.61	1,484.54	0.00	1,484.54
2438	3,868.78	0.00	121.34	0.00	0.00	0.00	3,868.78	121.34	0.00	121.34
2439	33,219.85	0.15	81.99	1,436.19	233.63	0.00	34,656.04	82.13	233.63	315.76
Totals	1,176,280.51	2,676.05	7,551.50	134,870.34	21,939.36	0.00	1,311,150.85	10,227.55	21,939.36	32,166.91
	89.71%	26.17%	73.83%	10.29%	100.00%	0.00%		31.80%	68.20%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.23 - Effluent Loads of Total Copper into Galveston Bay in 1990 With Revised Typical Pollutant Concentrations**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.41	0.00	787.57	110.24	0.00	792.03	0.41	110.24	110.65
0802	49.91	0.20	0.00	299.23	41.88	0.00	349.14	0.20	41.88	42.08
0901	1,182.05	47.66	0.00	892.97	124.99	0.00	2,075.02	47.66	124.99	172.65
0902	192.67	20.99	0.00	118.99	16.66	0.00	311.67	20.99	16.66	37.65
1001	2,405.55	68.47	0.00	1,196.17	167.43	0.00	3,601.72	68.47	167.43	235.90
1005	7,695.70	700.68	150.41	0.03	0.00	0.00	7,695.73	851.09	0.00	851.09
1006	45,974.45	826.17	88.62	17,869.98	2,443.64	12.52	63,844.43	914.79	2,456.16	3,370.95
1007	44,955.61	382.85	82.24	75,921.55	10,626.88	0.00	120,877.16	465.09	10,626.88	11,091.97
1013	9.63	1.02	0.00	6,619.27	926.51	0.00	6,628.90	1.02	926.51	927.54
1014	65.47	6.51	0.00	11,249.12	1,574.56	0.00	11,314.59	6.51	1,574.56	1,581.07
1101	0.00	0.00	0.00	3,002.88	420.32	0.00	3,002.88	0.00	420.32	420.32
1102	0.00	0.00	0.00	2,887.69	404.20	0.00	2,887.69	0.00	404.20	404.20
1103	19.26	0.00	2.79	982.63	137.54	0.00	1,001.89	2.79	137.54	140.33
1104	0.00	0.00	0.00	71.97	10.07	0.00	71.97	0.00	10.07	10.07
1105	0.00	0.00	0.00	120.69	16.89	0.00	120.69	0.00	16.89	16.89
1107	3,026.78	7.53	0.00	9.67	1.35	0.00	3,036.45	7.53	1.35	8.89
1108	3.25	0.12	0.00	15.03	2.10	0.00	18.28	0.12	2.10	2.22
1113	0.00	0.00	0.00	2,244.90	314.22	0.00	2,244.90	0.00	314.22	314.22
2421	434,463.47	6.81	1.56	2,117.35	296.37	0.00	436,580.83	8.37	296.37	304.74
2422	417,454.63	2,077.93	0.00	194.65	27.25	0.00	417,649.29	2,077.93	27.25	2,105.18
2424	0.87	0.08	0.00	2,037.35	285.17	0.00	2,038.22	0.08	285.17	285.25
2425	115,282.77	575.97	0.00	138.86	19.44	0.00	115,421.64	575.97	19.44	595.40
2426	14.46	1.39	0.00	1,393.76	195.09	0.00	1,408.22	1.39	195.09	196.48
2427	61,487.45	467.60	1.91	0.00	0.00	0.00	61,487.45	469.51	0.00	469.51
2429	98.57	9.08	0.00	0.00	0.00	0.00	98.57	9.08	0.00	9.08
2430	4.99	0.46	0.00	0.00	0.00	0.00	4.99	0.46	0.00	0.46
2431	82.27	7.58	0.00	2,255.36	315.69	0.00	2,337.63	7.58	315.69	323.26
2432	0.00	0.00	0.00	985.62	137.96	0.00	985.62	0.00	137.96	137.96
2436	0.00	0.00	0.00	20.89	2.92	0.00	20.89	0.00	2.92	2.92
2437	4,717.61	429.55	0.00	0.00	0.00	0.00	4,717.61	429.55	0.00	429.55
2438	3,868.78	0.00	164.31	0.00	0.00	0.00	3,868.78	164.31	0.00	164.31
2439	33,219.85	165.21	17.44	1,436.19	201.03	0.00	34,656.04	182.65	201.03	383.67
Totals	1,176,280.51	5,804.26	509.28	134,870.34	18,820.40	12.52	1,311,150.85	6,313.54	18,832.93	25,146.47
	89.71%	91.93%	8.07%	10.29%	99.93%	0.07%		25.11%	74.89%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.24 - Effluent Loads of Total Lead into Galveston Bay in 1990 With Revised Typical Pollutant Concentrations**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.33	0.00	787.57	134.07	0.00	792.03	0.33	134.07	134.41
0802	49.91	0.00	0.00	299.23	50.94	0.00	349.14	0.00	50.94	50.94
0901	1,182.05	25.53	0.94	892.97	152.02	0.00	2,075.02	26.47	152.02	178.48
0902	192.67	9.59	0.00	118.99	20.26	0.00	311.67	9.59	20.26	29.85
1001	2,405.55	11.13	0.00	1,196.17	203.63	0.00	3,601.72	11.13	203.63	214.76
1005	7,695.70	547.48	0.00	0.03	0.00	0.00	7,695.73	547.48	0.00	547.48
1006	45,974.45	201.37	289.82	17,869.98	3,042.12	0.00	63,844.43	491.19	3,042.12	3,533.30
1007	44,955.61	206.70	44.87	75,921.55	12,924.59	0.00	120,877.16	251.57	12,924.59	13,176.16
1013	9.63	0.88	0.00	6,619.27	1,126.84	0.00	6,628.90	0.88	1,126.84	1,127.72
1014	65.47	2.44	0.00	11,249.12	1,915.01	0.00	11,314.59	2.44	1,915.01	1,917.45
1101	0.00	0.00	0.00	3,002.88	511.20	0.00	3,002.88	0.00	511.20	511.20
1102	0.00	0.00	0.00	2,887.69	491.59	0.00	2,887.69	0.00	491.59	491.59
1103	19.26	0.00	0.00	982.63	167.28	0.00	1,001.89	0.00	167.28	167.28
1104	0.00	0.00	0.00	71.97	12.25	0.00	71.97	0.00	12.25	12.25
1105	0.00	0.00	0.00	120.69	20.55	0.00	120.69	0.00	20.55	20.55
1107	3,026.78	0.00	0.00	9.67	1.65	0.00	3,036.45	0.00	1.65	1.65
1108	3.25	0.10	0.00	15.03	2.56	0.00	18.28	0.10	2.56	2.65
1113	0.00	0.00	0.00	2,244.90	382.16	0.00	2,244.90	0.00	382.16	382.16
2421	434,463.47	13.62	0.00	2,117.35	360.45	0.00	436,580.83	13.62	360.45	374.07
2422	417,454.63	0.00	0.00	194.65	33.14	0.00	417,649.29	0.00	33.14	33.14
2424	0.87	0.06	0.00	2,037.35	346.83	0.00	2,038.22	0.06	346.83	346.90
2425	115,282.77	1.83	0.00	138.86	23.64	0.00	115,421.64	1.83	23.64	25.47
2426	14.46	0.87	0.00	1,393.76	237.27	0.00	1,408.22	0.87	237.27	238.14
2427	61,487.45	269.40	3.83	0.00	0.00	0.00	61,487.45	273.24	0.00	273.24
2429	98.57	7.36	0.00	0.00	0.00	0.00	98.57	7.36	0.00	7.36
2430	4.99	0.37	0.00	0.00	0.00	0.00	4.99	0.37	0.00	0.37
2431	82.27	6.14	0.00	2,255.36	383.94	0.00	2,337.63	6.14	383.94	390.09
2432	0.00	0.00	0.00	985.62	167.79	0.00	985.62	0.00	167.79	167.79
2436	0.00	0.00	0.00	20.89	3.56	0.00	20.89	0.00	3.56	3.56
2437	4,717.61	722.33	0.00	0.00	0.00	0.00	4,717.61	722.33	0.00	722.33
2438	3,868.78	0.00	40.83	0.00	0.00	0.00	3,868.78	40.83	0.00	40.83
2439	33,219.85	0.18	0.00	1,436.19	244.49	0.00	34,656.04	0.18	244.49	244.67
Totals	1,176,280.51	2,027.71	380.29	134,870.34	22,959.80	0.00	1,311,150.85	2,408.00	22,959.80	25,367.80
	89.71%	84.21%	15.79%	10.29%	100.00%	0.00%		9.49%	90.51%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.25 - Effluent Loads of Total Mercury into Galveston Bay in 1990 With Revised Typical Pollutant Concentrations**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	0.00	0.00	787.57	0.89	0.00	792.03	0.00	0.89	0.90
0802	49.91	0.00	0.00	299.23	0.34	0.00	349.14	0.00	0.34	0.34
0901	1,182.05	1.02	0.00	892.97	1.01	0.00	2,075.02	1.02	1.01	2.04
0902	192.67	0.79	0.00	118.99	0.14	0.00	311.67	0.79	0.14	0.93
1001	2,405.55	1.23	0.00	1,196.17	1.36	0.00	3,601.72	1.23	1.36	2.59
1005	7,695.70	5.95	0.00	0.03	0.00	0.00	7,695.73	5.95	0.00	5.95
1006	45,974.45	22.07	2.11	17,869.98	20.28	0.00	63,844.43	24.19	20.28	44.47
1007	44,955.61	2.76	0.00	75,921.55	86.16	0.00	120,877.16	2.76	86.16	88.93
1013	9.63	0.01	0.00	6,619.27	7.51	0.00	6,628.90	0.01	7.51	7.53
1014	65.47	0.11	0.00	11,249.12	12.77	0.00	11,314.59	0.11	12.77	12.88
1101	0.00	0.00	0.00	3,002.88	3.41	0.00	3,002.88	0.00	3.41	3.41
1102	0.00	0.00	0.00	2,887.69	3.28	0.00	2,887.69	0.00	3.28	3.28
1103	19.26	0.00	0.00	982.63	1.12	0.00	1,001.89	0.00	1.12	1.12
1104	0.00	0.00	0.00	71.97	0.08	0.00	71.97	0.00	0.08	0.08
1105	0.00	0.00	0.00	120.69	0.14	0.00	120.69	0.00	0.14	0.14
1107	3,026.78	0.00	0.00	9.67	0.01	0.00	3,036.45	0.00	0.01	0.01
1108	3.25	0.00	0.00	15.03	0.02	0.00	18.28	0.00	0.02	0.02
1113	0.00	0.00	0.00	2,244.90	2.55	0.00	2,244.90	0.00	2.55	2.55
2421	434,463.47	0.23	0.00	2,117.35	2.40	0.00	436,580.83	0.23	2.40	2.63
2422	417,454.63	0.00	0.00	194.65	0.22	0.00	417,649.29	0.00	0.22	0.22
2424	0.87	0.00	0.00	2,037.35	2.31	0.00	2,038.22	0.00	2.31	2.31
2425	115,282.77	0.01	0.00	138.86	0.16	0.00	115,421.64	0.01	0.16	0.17
2426	14.46	0.01	0.00	1,393.76	1.58	0.00	1,408.22	0.01	1.58	1.60
2427	61,487.45	5.77	0.00	0.00	0.00	0.00	61,487.45	5.77	0.00	5.77
2429	98.57	0.05	0.00	0.00	0.00	0.00	98.57	0.05	0.00	0.05
2430	4.99	0.00	0.00	0.00	0.00	0.00	4.99	0.00	0.00	0.00
2431	82.27	0.04	0.00	2,255.36	2.56	0.00	2,337.63	0.04	2.56	2.60
2432	0.00	0.00	0.00	985.62	1.12	0.00	985.62	0.00	1.12	1.12
2436	0.00	0.00	0.00	20.89	0.02	0.00	20.89	0.00	0.02	0.02
2437	4,717.61	6.28	0.00	0.00	0.00	0.00	4,717.61	6.28	0.00	6.28
2438	3,868.78	0.00	10.03	0.00	0.00	0.00	3,868.78	10.03	0.00	10.03
2439	33,219.85	0.00	0.00	1,436.19	1.63	0.00	34,656.04	0.00	1.63	1.63
Totals	1,176,280.51	46.37	12.15	134,870.34	153.07	0.00	1,311,150.85	58.52	153.07	211.58
	89.71%	79.24%	20.76%	10.29%	100.00%	0.00%		27.66%	72.34%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.26 - Effluent Loads of Total Zinc into Galveston Bay in 1990 With Revised Typical Pollutant Concentrations**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Stream Segment	Actual Average Industrial Flow (MG/yr)	Estimated Industrial Load With TPC (kg/yr)	Measured Industrial Load (kg/yr)	Actual Average Municipal Flow (MG/yr)	Estimated Municipal Load With TPC (kg/yr)	Measured Municipal Load (kg/yr)	Total Flow (MG/yr)	Total Industrial Load (kg/yr)	Total Municipal Load (kg/yr)	Total Load (kg/yr)
0801	4.46	1.32	0.00	787.57	491.60	0.00	792.03	1.32	491.60	492.92
0802	49.91	0.00	0.00	299.23	186.78	0.00	349.14	0.00	186.78	186.78
0901	1,182.05	191.23	1.76	892.97	557.39	0.00	2,075.02	192.99	557.39	750.38
0902	192.67	103.63	0.00	118.99	74.28	0.00	311.67	103.63	74.28	177.91
1001	2,405.55	47.28	2,280.07	1,196.17	746.65	0.00	3,601.72	2,327.35	746.65	3,073.99
1005	7,695.70	2,003.12	283.38	0.03	0.02	0.00	7,695.73	2,286.50	0.02	2,286.52
1006	45,974.45	5,339.34	299.99	17,869.98	10,897.32	54.30	63,844.43	5,639.33	10,951.62	16,590.94
1007	44,955.61	896.24	7,739.81	75,921.55	47,390.15	0.00	120,877.16	8,636.06	47,390.15	56,026.20
1013	9.63	5.92	3.40	6,619.27	4,131.74	0.00	6,628.90	9.32	4,131.74	4,141.07
1014	65.47	53.72	1.46	11,249.12	7,021.69	0.00	11,314.59	55.17	7,021.69	7,076.86
1101	0.00	0.00	0.00	3,002.88	1,874.39	0.00	3,002.88	0.00	1,874.39	1,874.39
1102	0.00	0.00	0.00	2,887.69	1,802.49	0.00	2,887.69	0.00	1,802.49	1,802.49
1103	19.26	0.00	26.55	982.63	613.36	0.00	1,001.89	26.55	613.36	639.91
1104	0.00	0.00	0.00	71.97	44.92	0.00	71.97	0.00	44.92	44.92
1105	0.00	0.00	0.00	120.69	75.33	0.00	120.69	0.00	75.33	75.33
1107	3,026.78	0.00	189.04	9.67	6.03	0.00	3,036.45	189.04	6.03	195.07
1108	3.25	0.21	0.00	15.03	9.38	0.00	18.28	0.21	9.38	9.59
1113	0.00	0.00	0.00	2,244.90	1,401.26	0.00	2,244.90	0.00	1,401.26	1,401.26
2421	434,463.47	108.79	0.00	2,117.35	1,321.65	0.00	436,580.83	108.79	1,321.65	1,430.44
2422	417,454.63	0.00	0.00	194.65	121.50	0.00	417,649.29	0.00	121.50	121.50
2424	0.87	0.26	0.00	2,037.35	1,271.71	0.00	2,038.22	0.26	1,271.71	1,271.97
2425	115,282.77	7.24	0.00	138.86	86.68	0.00	115,421.64	7.24	86.68	93.92
2426	14.46	6.64	0.00	1,393.76	869.98	0.00	1,408.22	6.64	869.98	876.62
2427	61,487.45	965.70	732.97	0.00	0.00	0.00	61,487.45	1,698.67	0.00	1,698.67
2429	98.57	29.16	0.00	0.00	0.00	0.00	98.57	29.16	0.00	29.16
2430	4.99	1.48	0.00	0.00	0.00	0.00	4.99	1.48	0.00	1.48
2431	82.27	24.34	0.00	2,255.36	1,407.79	0.00	2,337.63	24.34	1,407.79	1,432.13
2432	0.00	0.00	0.00	985.62	615.22	0.00	985.62	0.00	615.22	615.22
2436	0.00	0.00	0.00	20.89	13.04	0.00	20.89	0.00	13.04	13.04
2437	4,717.61	3,555.68	186.28	0.00	0.00	0.00	4,717.61	3,741.95	0.00	3,741.95
2438	3,868.78	0.00	976.83	0.00	0.00	0.00	3,868.78	976.83	0.00	976.83
2439	33,219.85	0.72	32.55	1,436.19	896.47	0.00	34,656.04	33.27	896.47	929.74
Totals	1,176,280.51	13,342.00	12,754.09	134,870.34	83,928.82	54.30	1,311,150.85	26,096.09	83,983.12	110,079.21
	89.71%	51.13%	48.87%	10.29%	99.94%	0.06%		23.71%	76.29%	

Note that Water Quality Segments 2423, 2428, 2433, 2434, and 2435 have no permitted discharges to them and are not included

**Table 4.27 - Summary of Effluent Loads of Constituents into Galveston Bay in 1990**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Const.		Estimated Industrial Load With TPC	Measured Industrial Load	Estimated Municipal Load With TPC	Measured Municipal Load	Total Industrial Load	Total Municipal Load	Estimated Total Load	Measured Total Load	Total Load
Total Flow	(MG/yr) This Study Pacheco et al.		1,176,281 89.7%		134,870 10.3%	1,176,281	134,870	0 0.0% 2.0%	1,311,151 100.0% 98.0%	1,311,151
Process Flow	(MG/yr) This Study Pacheco et al.		40,717 23.2%		134,870 76.8%			0 0.0% 13.0%	175,587 100.0% 87.0%	175,587
BOD <sub>5</sub>	(kg/yr) This Study Pacheco et al.	14,679 0.5%	3,244,313 99.5%	150,962 10.8%	1,244,600 89.2%	3,258,992 70.0%	1,395,562 30.0%	165,642 3.6% 41.0%	4,488,912 96.4% 59.0%	4,654,554
TSS	(kg/yr) This Study Pacheco et al.	102,286 1.5%	6,934,811 98.5%	0 0.0%	2,667,367 100.0%	7,037,097 72.5%	2,667,367 27.5%	102,286 1.1% 26.0%	9,602,178 98.9% 74.0%	9,704,464
Oil & Grease	(kg/yr) This Study Pacheco et al.	60,286 10.6%	507,417 89.4%	5,714,439 100.0%	0 0.0%	567,703 9.0%	5,714,439 91.0%	5,774,725 91.9% 92.0%	507,417 8.1% 8.0%	6,282,142
Total N	(kg/yr) This Study Pacheco et al.	1,282,425 100.0%	0 0.0%	7,143,048 100.0%	0 0.0%	1,282,425 15.2%	7,143,048 84.8%	8,425,474 100.0% 100.0%	0 0.0% 0.0%	8,425,474
Total P	(kg/yr) This Study Pacheco et al.	427,192 99.1%	3,950 0.9%	3,571,524 100.0%	0 0.0%	431,142 10.8%	3,571,524 89.2%	3,998,716 99.9% 97.0%	3,950 0.1% 3.0%	4,002,666
Total Arsenic	(kg/yr) This Study Pacheco et al.	3,792 99.9%	5 0.1%	16,327 100.0%	0 0.0%	3,796 18.9%	16,327 81.1%	20,118 100.0% 99.0%	5 0.0% 1.0%	20,123
Total Cadmium	(kg/yr) This Study Pacheco et al.	775 98.7%	10 1.3%	5,612 100.0%	0 0.0%	785 12.3%	5,612 87.7%	6,387 99.8% 98.0%	10 0.2% 2.0%	6,397
Total Chromium	(kg/yr) This Study Pacheco et al.	2,676 26.2%	7,551 73.8%	21,939 100.0%	0 0.0%	10,228 31.8%	21,939 68.2%	24,615 76.5% 76.0%	7,551 23.5% 24.0%	32,167
Total Copper	(kg/yr) This Study Pacheco et al.	8,618 94.4%	509 5.6%	18,820 99.9%	13 0.1%	9,127 32.6%	18,833 67.4%	27,439 98.1% 98.0%	522 1.9% 2.0%	27,960
Total Iron	(kg/yr) This Study Pacheco et al.	65,610 100.0%	29 0.0%	357,152 100.0%	0 0.0%	65,639 15.5%	357,152 84.5%	422,762 100.0% 99.0%	29 0.0% 1.0%	422,791
Total Lead	(kg/yr) This Study Pacheco et al.	2,028 84.2%	380 15.8%	22,960 100.0%	0 0.0%	2,408 9.5%	22,960 90.5%	24,988 98.5% 87.0%	380 1.5% 13.0%	25,368
Total Mercury	(kg/yr) This Study Pacheco et al.	55 79.1%	12 20.9%	153 100.0%	0 0.0%	68 99.7%	153 0.3%	209 94.5% 86.0%	12 5.5% 14.0%	221
Total Zinc	(kg/yr) This Study Pacheco et al.	17,287 57.5%	12,754 42.5%	83,929 99.9%	54 0.1%	30,041 26.3%	83,983 73.7%	101,216 88.8% 62.0%	12,808 11.2% 38.0%	114,024
PCB	(kg/yr) This Study Pacheco et al.	0 0.0%	16 100.0%	0 0.0%	0 0.0%	16 100.0%	0 0.0%	0 0.0%	16 100.0%	16

residual, however, was reported by many discharges but usually as a minimum grab value, but, with no TPC for it, a load was not estimated.

#### **4.2.4 Potential Problem Area**

Releases from individual dischargers were assumed to be discharged to the Bay directly, to be dispersed into a mixing zone, and to experience the amount of dilution assumed by the TWC in its definition of mixing zones for estuarine systems. If the TWC surface water quality standards for the toxic materials being discharged were exceeded (essentially, if a 30-day average metals concentration exceeded the new TPC concentration given in Table 3.6), then that discharger were to be flagged as creating a potential problem. Dischargers have been flagged, but only one is, in fact, exceeding the limits for one of the metals, and that discharger will be discussed with TWC personnel before being identified.

### **4.3 TRIBUTARY LOADING**

#### **4.3.1 Introduction**

The results of calculations made to estimate stream loading into the Galveston Bay system are given here. The tributary source loadings considered consisted of the Trinity River, the San Jacinto River, and several bayous (Buffalo, White Oak, Brays, Huntington, Sims, and Green) around the Bay. Discrepancies among estimation methods and watersheds as well as trends in the data are discussed. For simplicity in discussion, the average concentration times the average flow estimator method is referred to as the "average" method, the Beale unstratified ratio estimator method as the "Beale" method, and the logarithmic regression method as the "log" method. Total annual loads are given in the next section on combined loadings.

In Gamblin (1993), results are tabulated for each constituent according to gauge number and method used. The constituents chosen to be analyzed are the same as those given above for point sources. For each constituent, graphs were made to show the temporal trends and differences among calculation methods, and spatial trends and differences among watersheds. For the temporal analysis, data derived from the Trinity and San Jacinto Rivers (USGS gauges 08066500 and 08072000, respectively) were graphed separately because the large flows from these rivers created substantially higher loading values than the other streams.

When only one concentration was sampled during a calendar year, the only estimation method applicable was the average method. Since the use of the logarithmic method was more limited than either the average or the Beale method because of methodology, less data were generated from the logarithmic method and the values were tabulated only. Loads from Lake Houston near Sheldon (USGS gauge 08072000) were obtained using the average method only because of the calculation methods used, and values were obtained only for the years 1983 through 1988 because this was the period in which spillage over the Lake Houston dam was

calculated. Temporal trends for the constituents by tributary and estimation method are discussed below.

#### **4.3.2 Temporal Analysis**

The results described here are from Gamblin (1993) and reflect loading calculations using the Beale method only. As noted above, tributary loads were calculated using the average method, the Beale method, and a logarithmic relationship between constituent load and flow. Because Gamblin found from the literature and his own analysis of tributary loads that the Beale method accounted most closely for concentration-flow relationships in the data, the results from use of this method were chosen to represent the tributary loads of constituents to the Bay. Doing so, however, reduced slightly the amount of loading data because of the calculation constraints of the Beale method; the average method produced more results than any other. This slight loss of results was considered acceptable to gain reliability of results.

##### **4.3.2.1 Biochemical Oxygen Demand, Total Suspended Solids, And Oil And Grease**

The results of calculations for 5-day biochemical oxygen demand ( $BOD_5$ ) loading are shown graphically in Figures 4.1 and 4.2. Figure 4.1 shows the annual load results for the Trinity River at Romayor and the San Jacinto River (from the Lake Houston spillway). There is considerable fluctuation in  $BOD_5$  loads throughout the 20-year period in the Trinity River while the overall temporal trend in the San Jacinto River over the 6-year period for which there are results appears to be toward decreasing  $BOD_5$  loading. The remaining tributaries loading results are shown in Figure 4.2. Overall, no definite temporal trends were evident, and year to year fluctuations reflect changes in rainfall primarily.

Total suspended solids loadings showed considerable fluctuation in the 1970s with peak loads in the Trinity River in 1973 and 1979 (Figure 4.3). Except for these high flow years, loads hovered in the 0.15 million kg/yr area for the Trinity River. Loads leaving Lake Houston were almost always below 50,000 kg/yr during the 1983 to 1988 period. In the tributaries, total suspended solids loads varied considerably and averaged between 50,000 kg/yr and 60,000 kg/yr for all except Huntington Bayou as shown in Figure 4.4. Loads in this latter bayou averaged below 0.5 million kg/yr.

No oil and grease data were available for the Trinity and San Jacinto Rivers, and so little oil and grease data were available for the tributaries (only prior to 1975) that no temporal trends were investigated for this constituent.

##### **4.3.2.2 Total Nitrogen And Total Phosphorus**

As shown in Figure 4.5, total nitrogen loads fluctuated about an average load of

**Figure 4.1 - Estimated Loads of BOD<sub>5</sub> into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988**

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Galveston Bay National Estuary Program

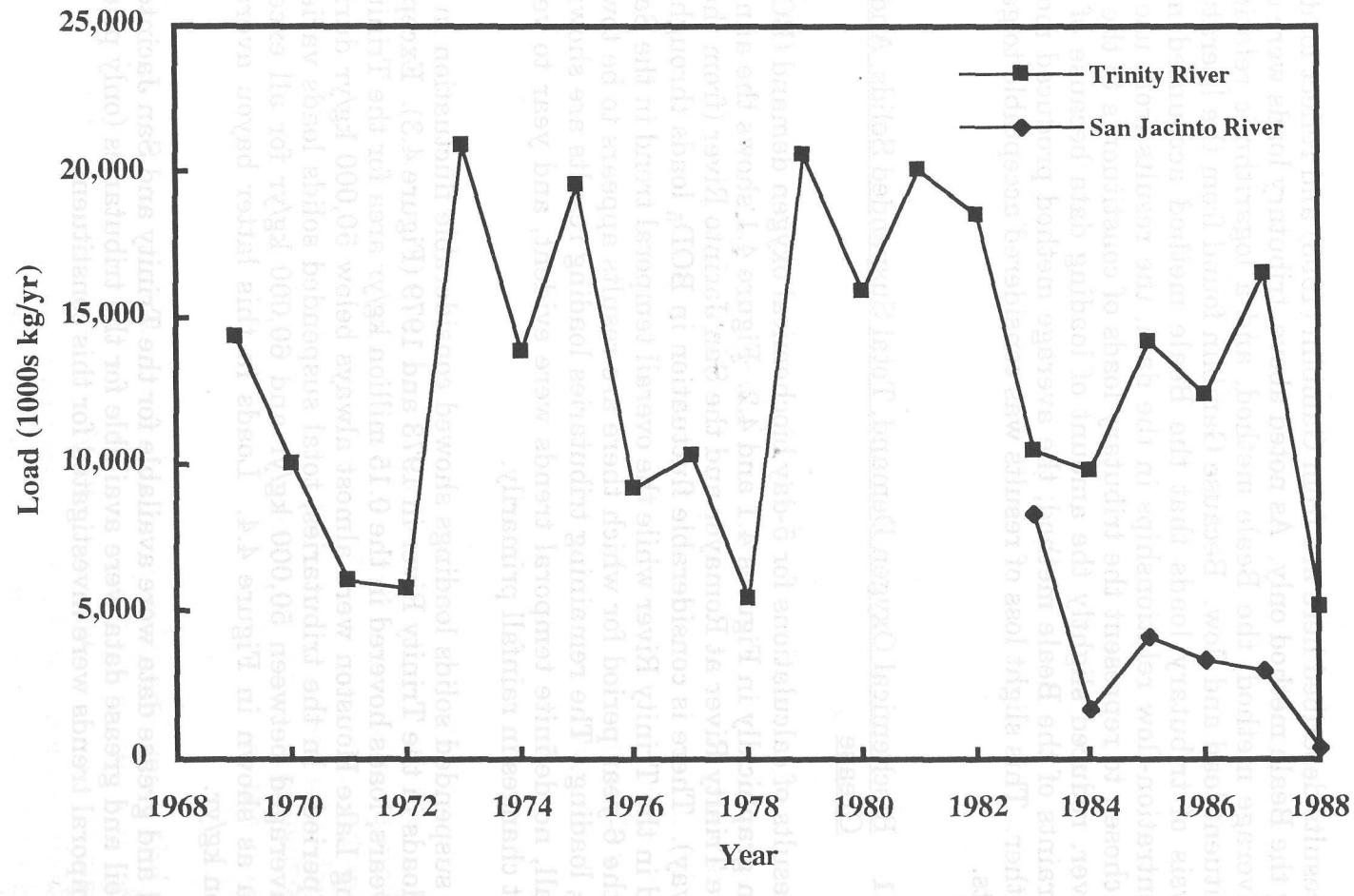
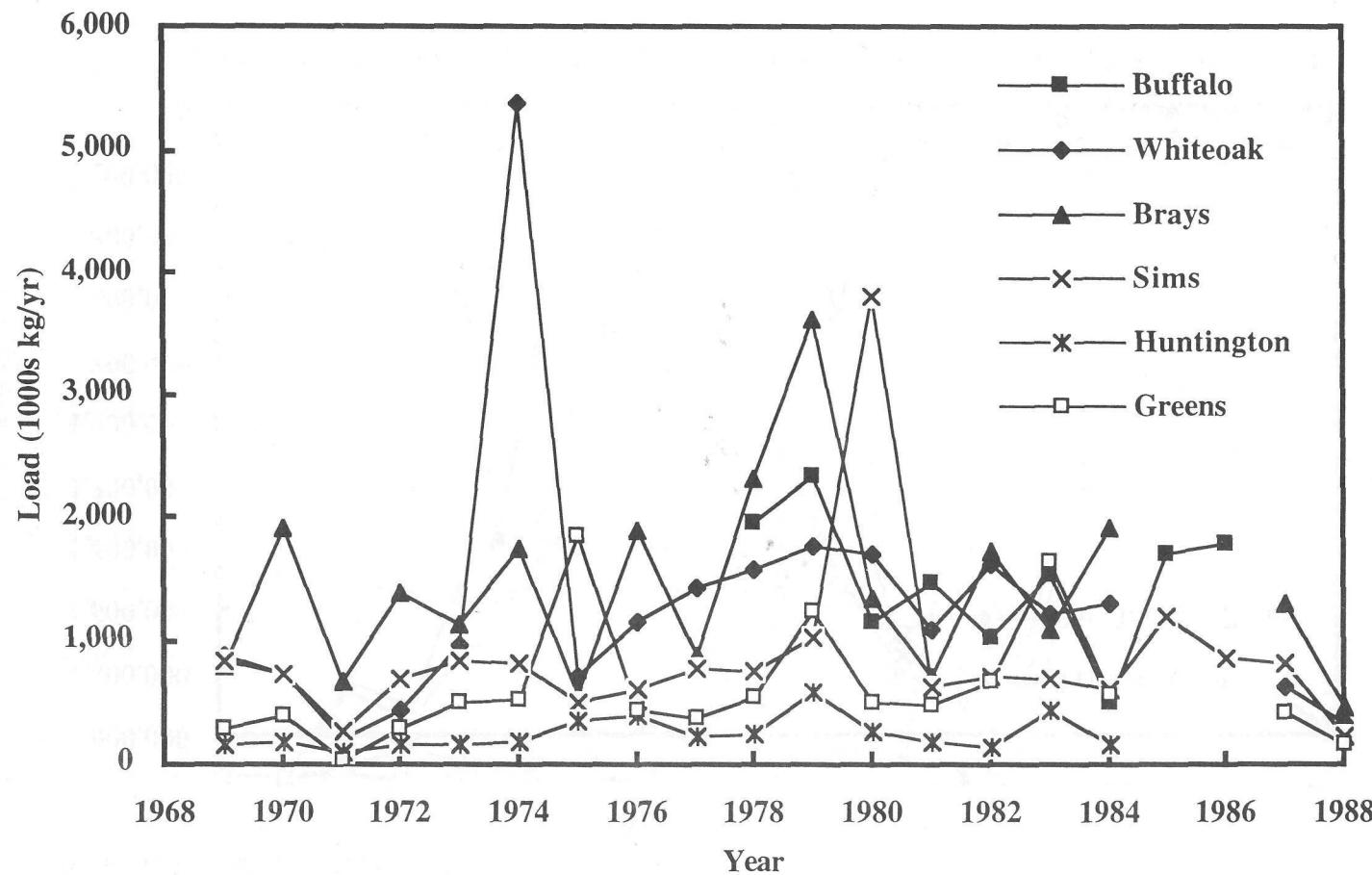


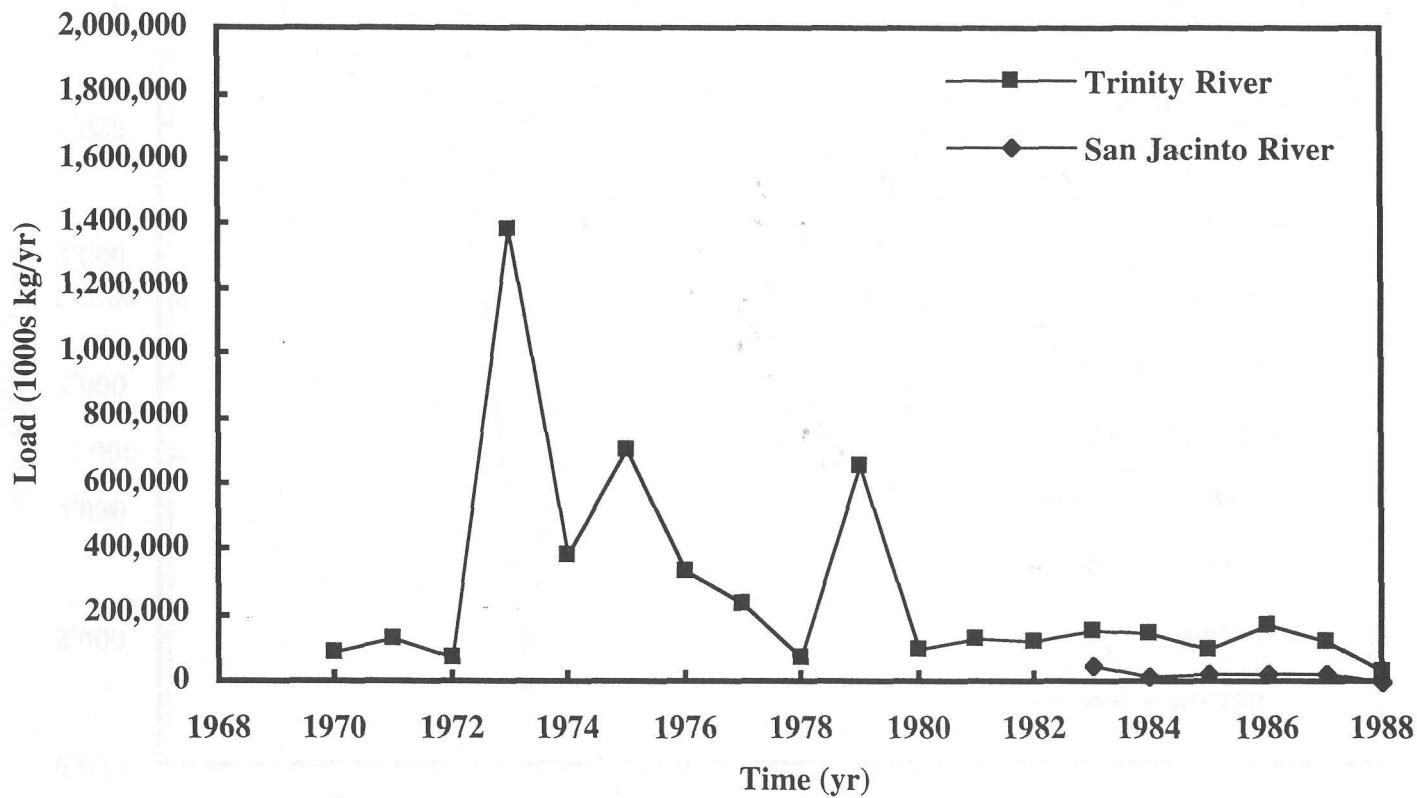
Figure 4.2 - Estimated Loads of BOD<sub>5</sub> into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

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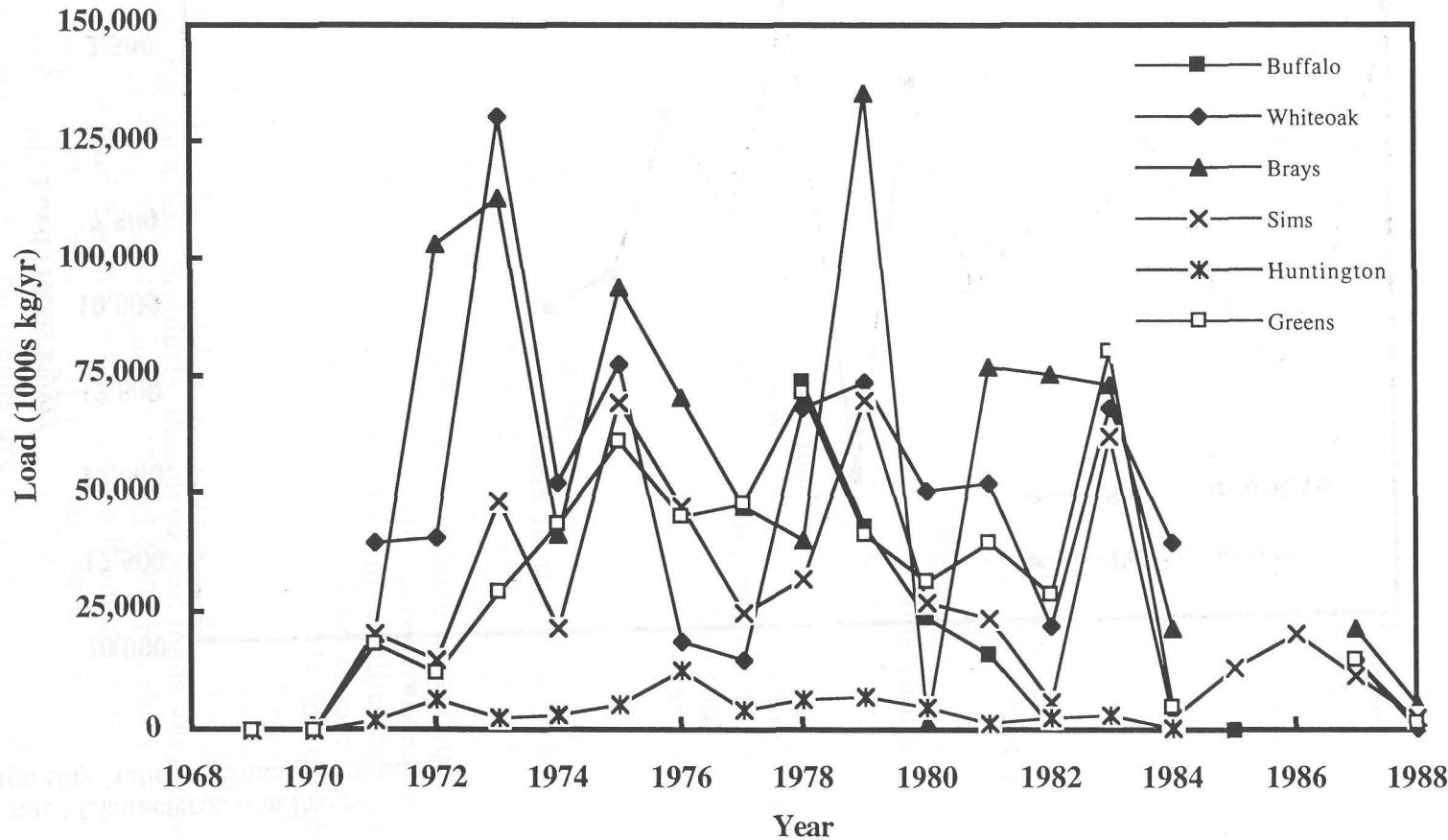
**Figure 4.3 - Estimated Loads of Total Suspended Solids into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988**

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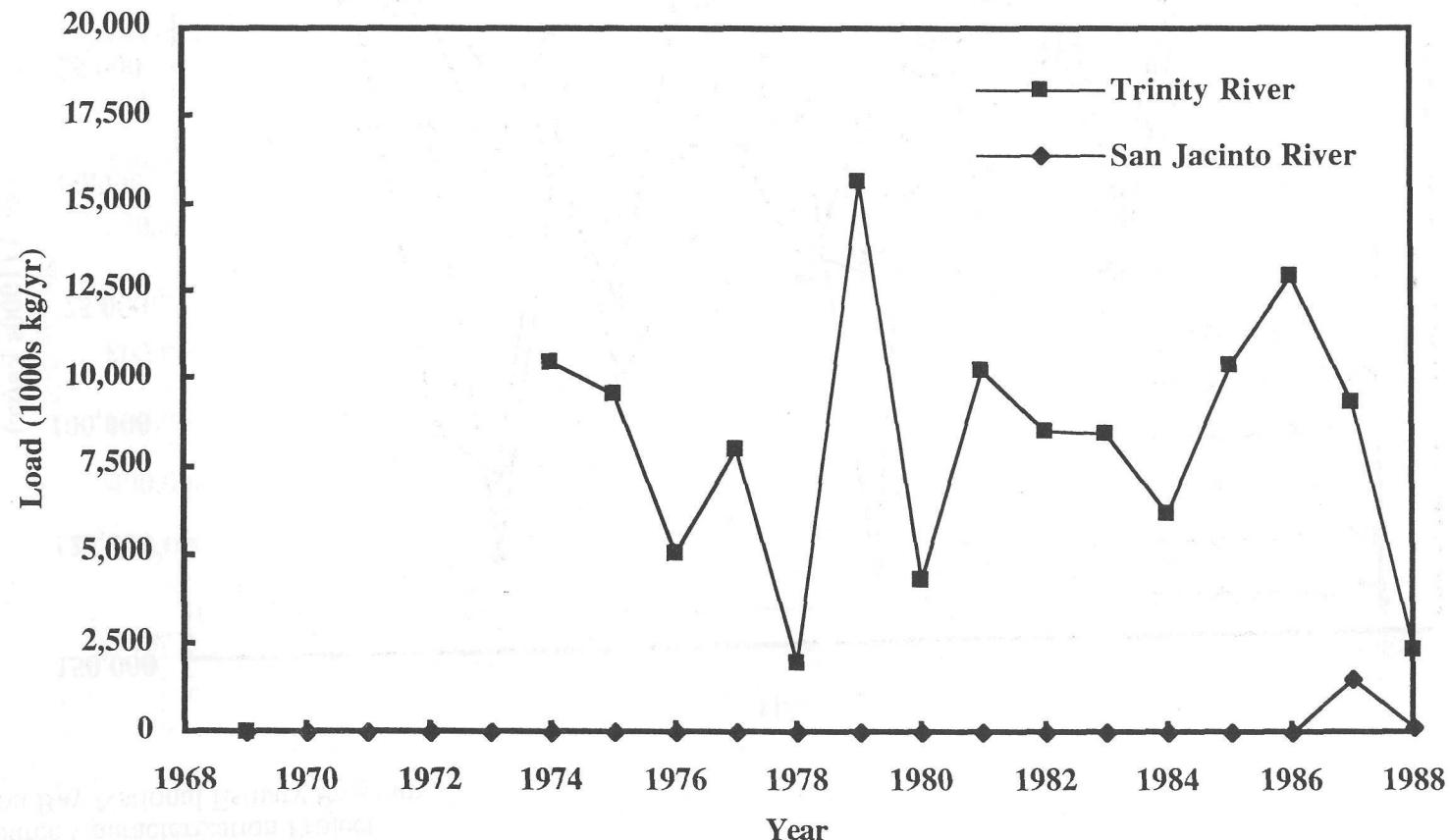
**Figure 4.4 - Estimated Loads of Total Suspended Solids into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988**

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Galveston Bay National Estuary Program



**Figure 4.5 - Estimated Loads of Total Nitrogen into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988**

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around 8 million kg/yr in the Trinity River. Values for the San Jacinto River were much lower. Tributary loads (Figure 4.6) were extremely scattered in time although there were hints at increasing loads over time in Sims Bayou and perhaps Brays Bayou.

Total phosphorus loads in the Trinity River and San Jacinto River are less variant in time than total nitrogen as shown in Figure 4.7. Except for the single high value in 1969, total phosphorus in the Trinity River would average about 1.2 million kg/yr while the San Jacinto River would be more in the 0.2 million kg/yr range (see Figure 4.8). Tributary loads, shown in Figure 4.8, also hint at increasing loads of total phosphorus.

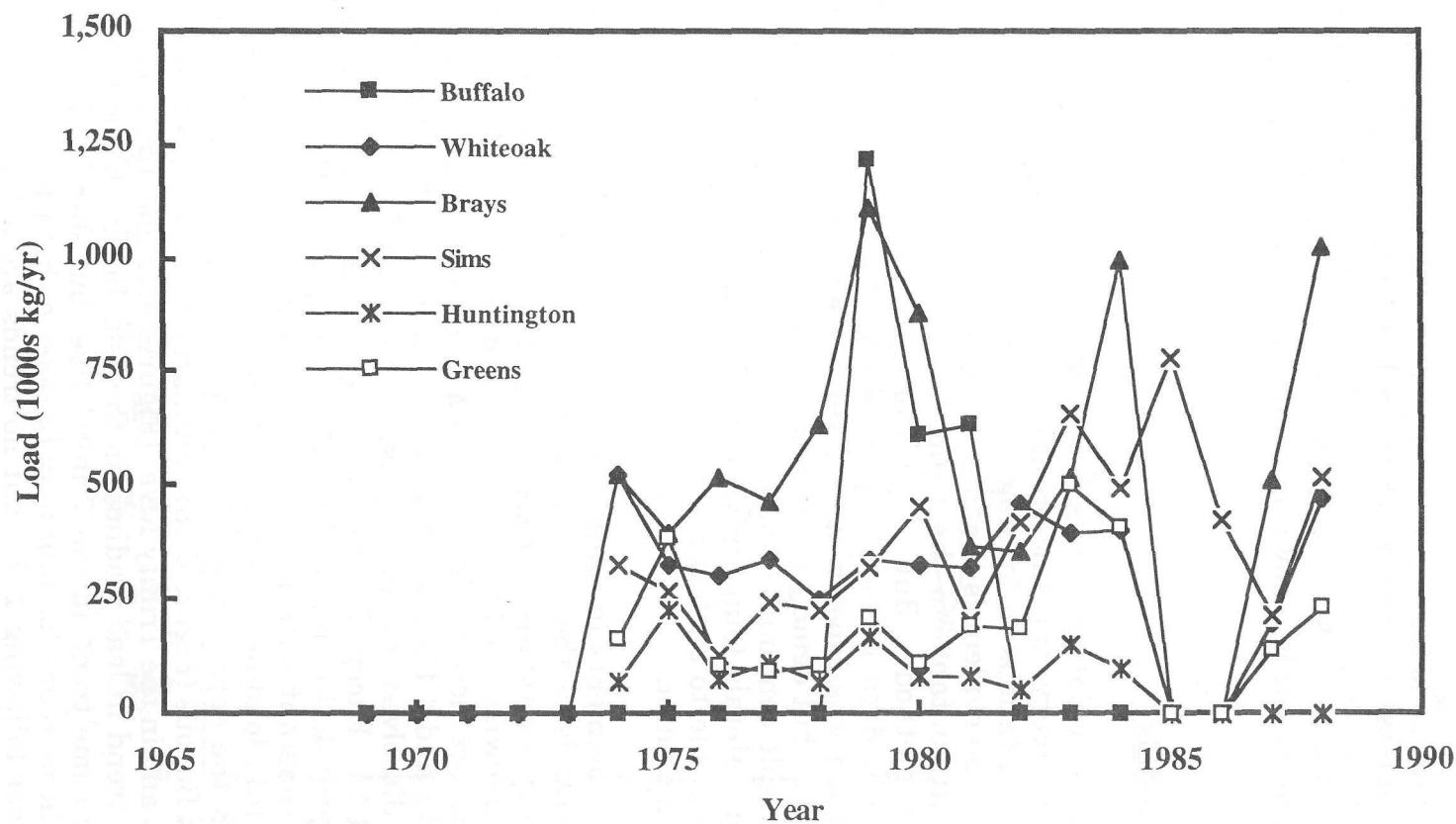
#### 4.3.2.3 Metals

The loading calculation results for dissolved arsenic, cadmium, chromium, copper, iron, lead, mercury, and zinc are illustrated in Figures 4.9 through 4.24. For each metal, the variations in loading from year to year are evident in each river and tributary. Also evident is the lack of annual loads calculated for some metals; this is partly attributable to the paucity of data and the constraints of the Beale estimation method. But of greater concern is the reliability of the metal concentration data given the possibility of sample contamination. If sample contamination was consistent over time, then loading values may be higher than they should be but demonstrate temporal changes somewhat reliably. On the other hand, if sample contamination was sporadic, then temporal trends may be skewed as a result. Metals found in very small concentrations (like cadmium) were the most susceptible to such contamination, and loading results for them should be viewed with caution.

With these comments in mind, some summary comments may be made about the temporal trends of the metals. Arsenic loadings in the Trinity River and San Jacinto River are relatively constant in time (Figure 4.9). Tributary loads (Figure 4.10) are likewise fairly constant except for Brays Bayou; there, rather large fluctuations are noted. The dissolved cadmium database is so fragmentary (see Figures 4.11 and 4.12) that little may be said about temporal trends, and the same is true for dissolved chromium (hexavalent plus trivalent) as illustrated in Figures 4.13 and 4.14. Except for the single high loads of dissolved copper in the Trinity River (Figure 4.15) and in Sims Bayou (Figure 4.16), loads for this metal are relatively constant with evidence of decreasing loads in the San Jacinto River. Dissolved iron loadings are relatively steady in the Trinity River except for high loadings in the early 1970s (Figure 4.17) and vary considerably in Buffalo and White Oak Bayous (Figure 4.18). Similarly, dissolved lead loads vary widely in the tributaries and in the Trinity River (Figures 4.19 and 4.20), but there is a consistent downward trend in lead loadings in the San Jacinto River after 1972 and a strong hint of the same trend in the Trinity River but starting in 1981. In Figure 4.21, decreases in mercury loading may be seen in both the Trinity River and the San Jacinto River following 1974, but no trends are evident in the tributary loads of mercury (Figure 4.22). As with mercury, decreases are also evident in dissolved zinc loads in the Trinity and San Jacinto Rivers (Figure 4.23) from the early and

Figure 4.6 - Estimated Loads of Total Nitrogen into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

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**Figure 4.7 - Estimated Loads of Total Phosphorus into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988**

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Galveston Bay National Estuary Program

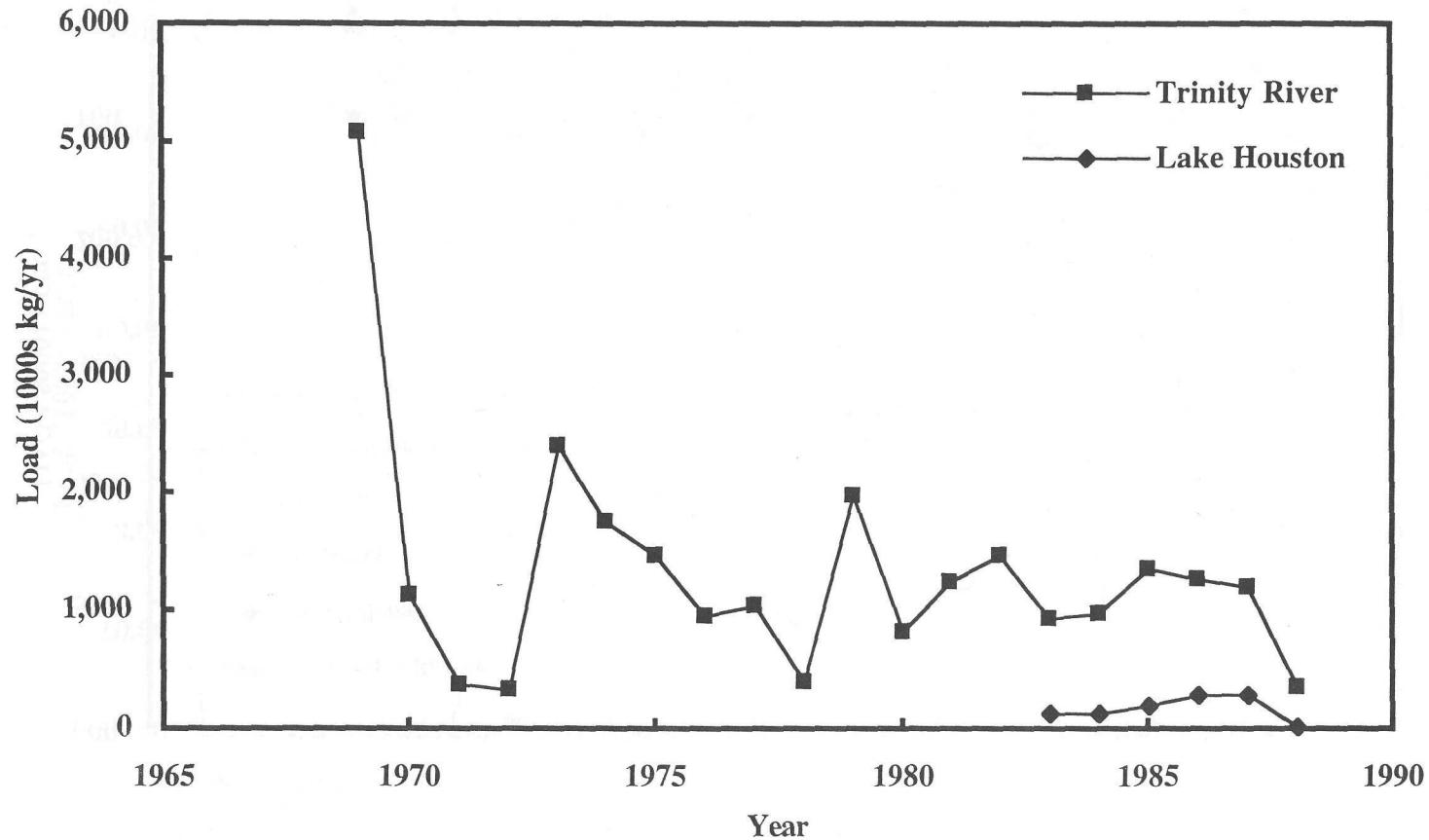
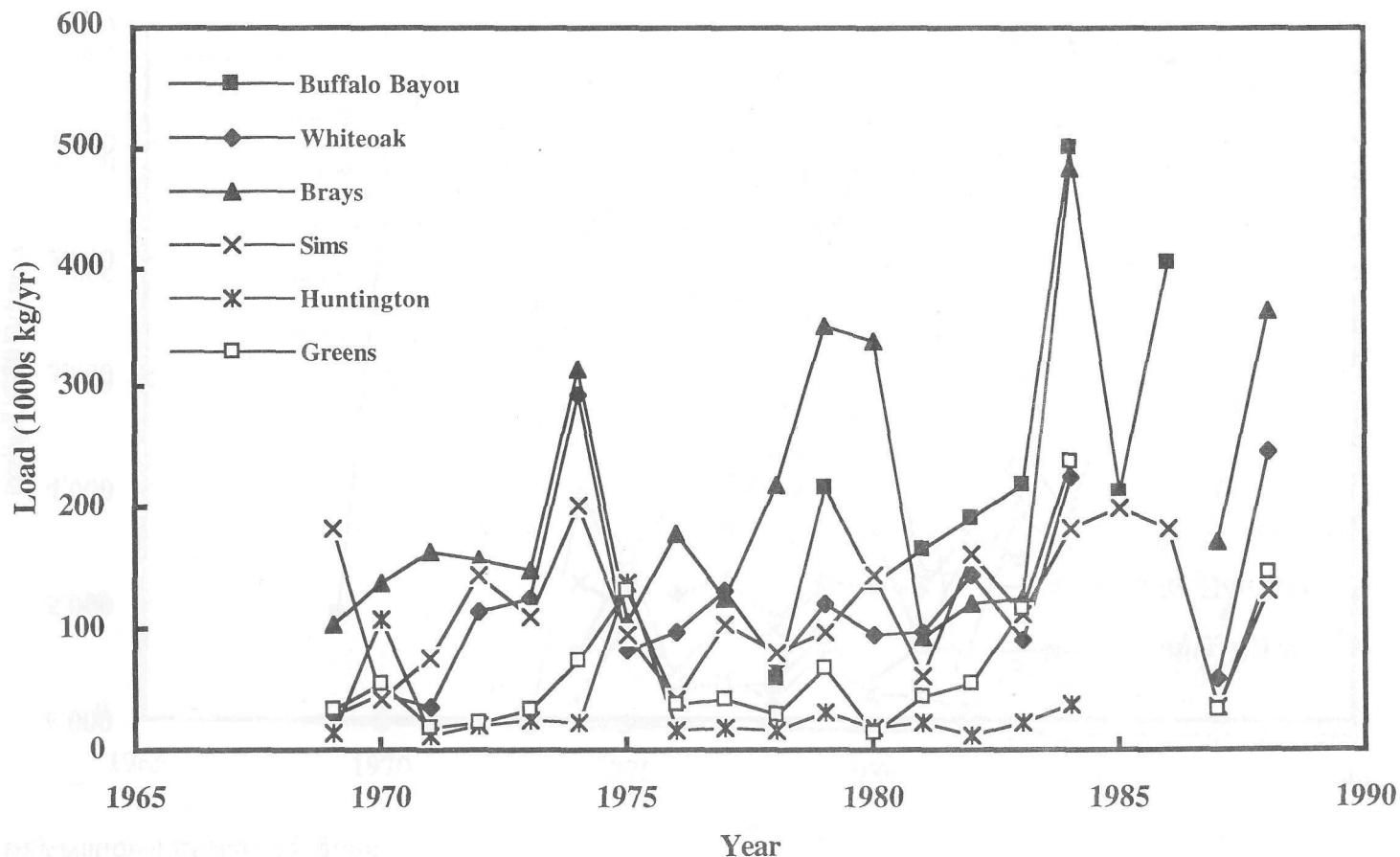


Figure 4.8 - Estimated Loads of Total Phosphorus into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

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**Figure 4.9 - Estimated Loads of Dissolved Arsenic into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988**

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Galveston Bay National Estuary Program

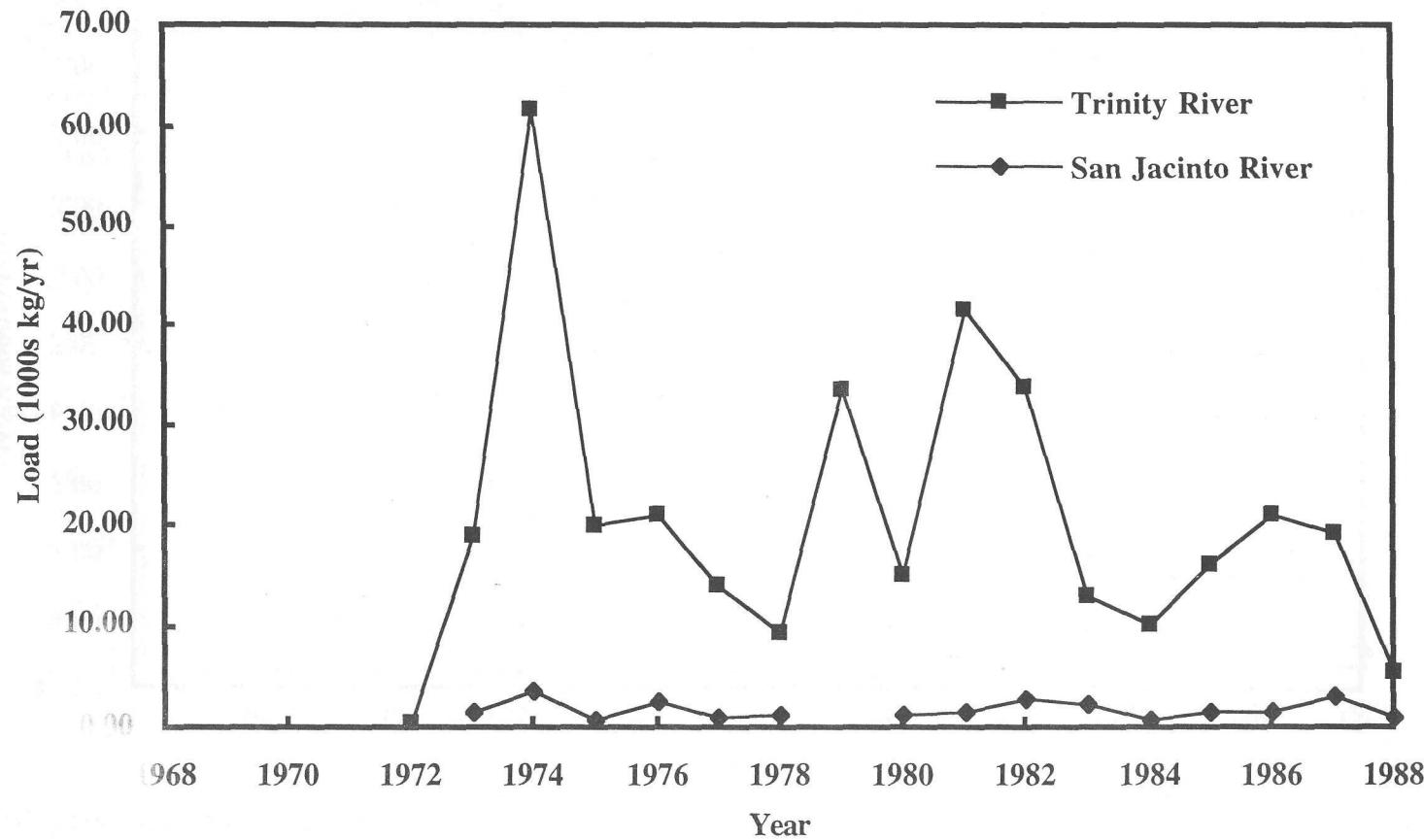


Figure 4.10 - Estimated Loads of Dissolved Arsenic into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

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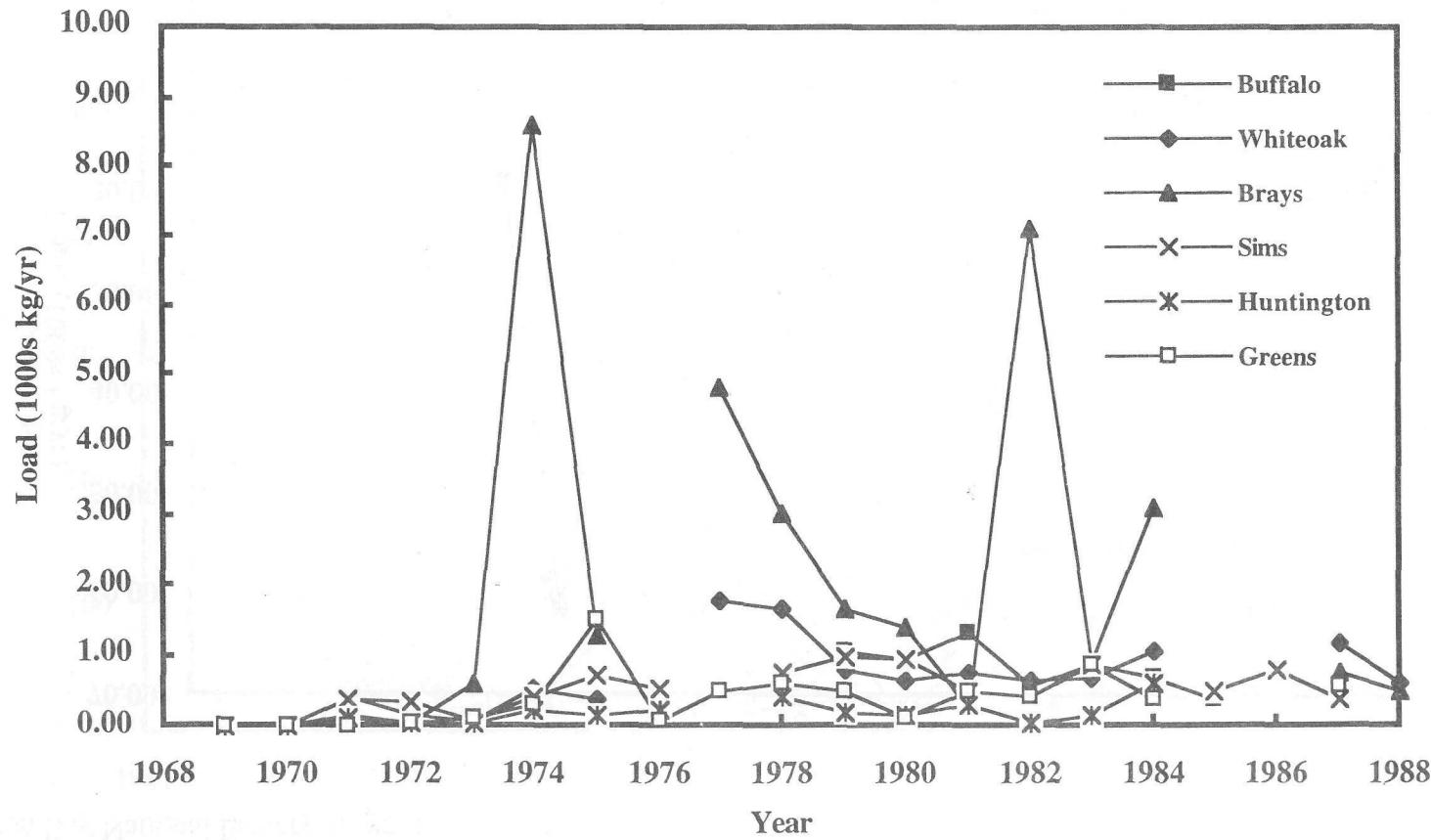


Figure 4.11 - Estimated Loads of Dissolved Cadmium into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988

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Galveston Bay National Estuary Program

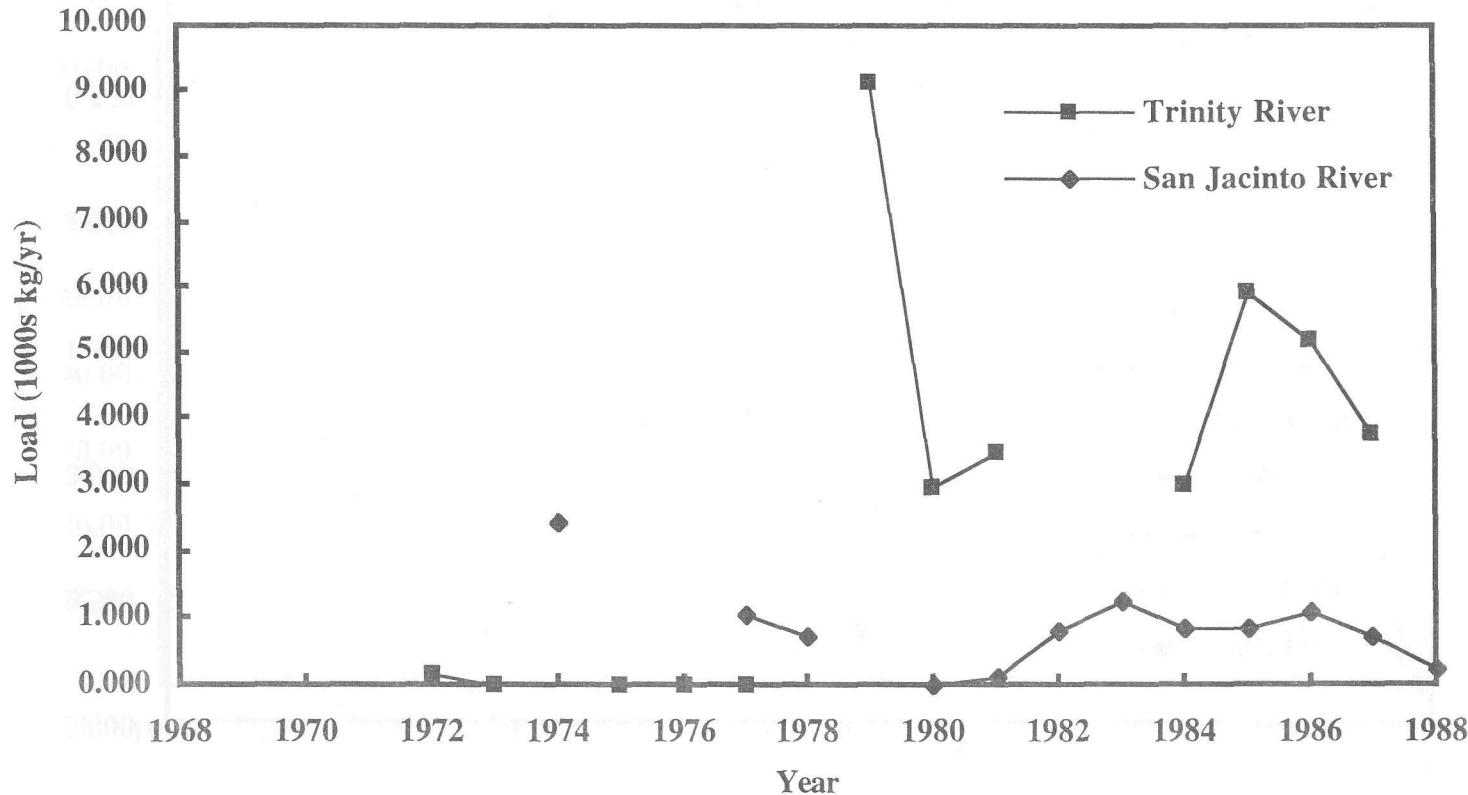


Figure 4.12 - Estimated Loads of Dissolved Cadmium into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

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Galveston Bay National Estuary Program

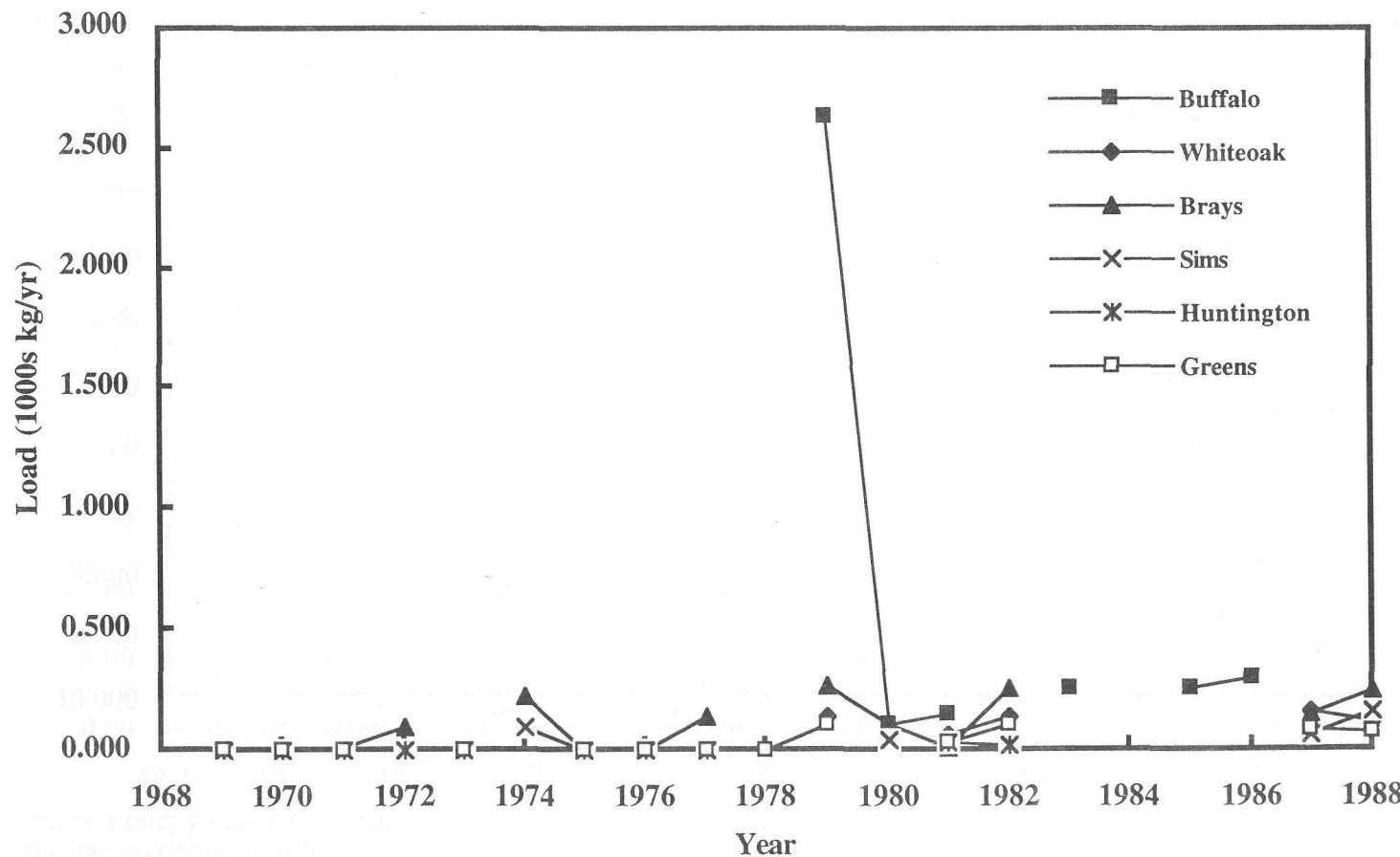


Figure 4.13 - Estimated Loads of Dissolved Total Chromium into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988

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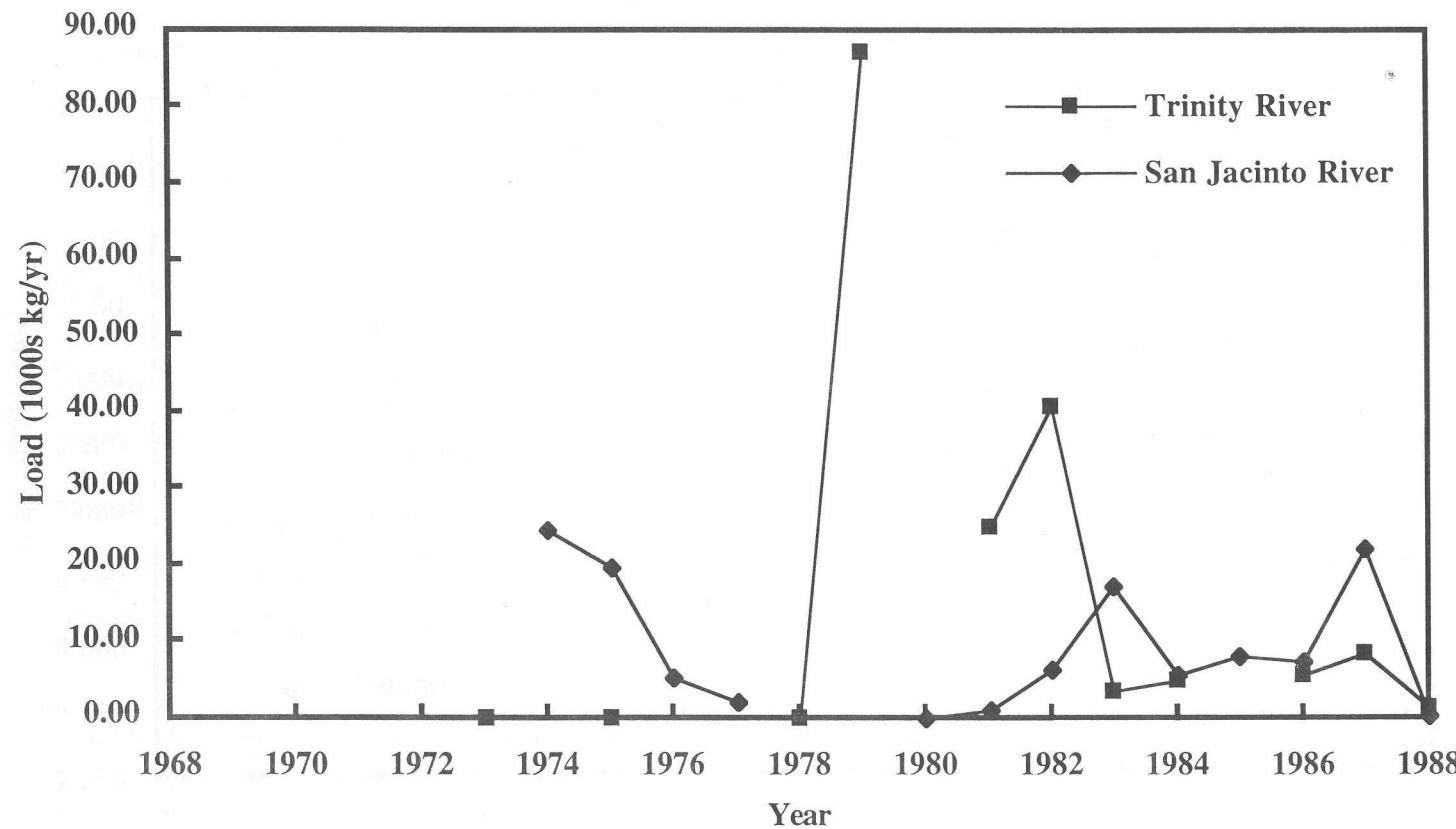


Figure 4.14 - Estimated Loads of Dissolved Total Chromium into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

Point Source Characterization Project  
Galveston Bay National Estuary Program

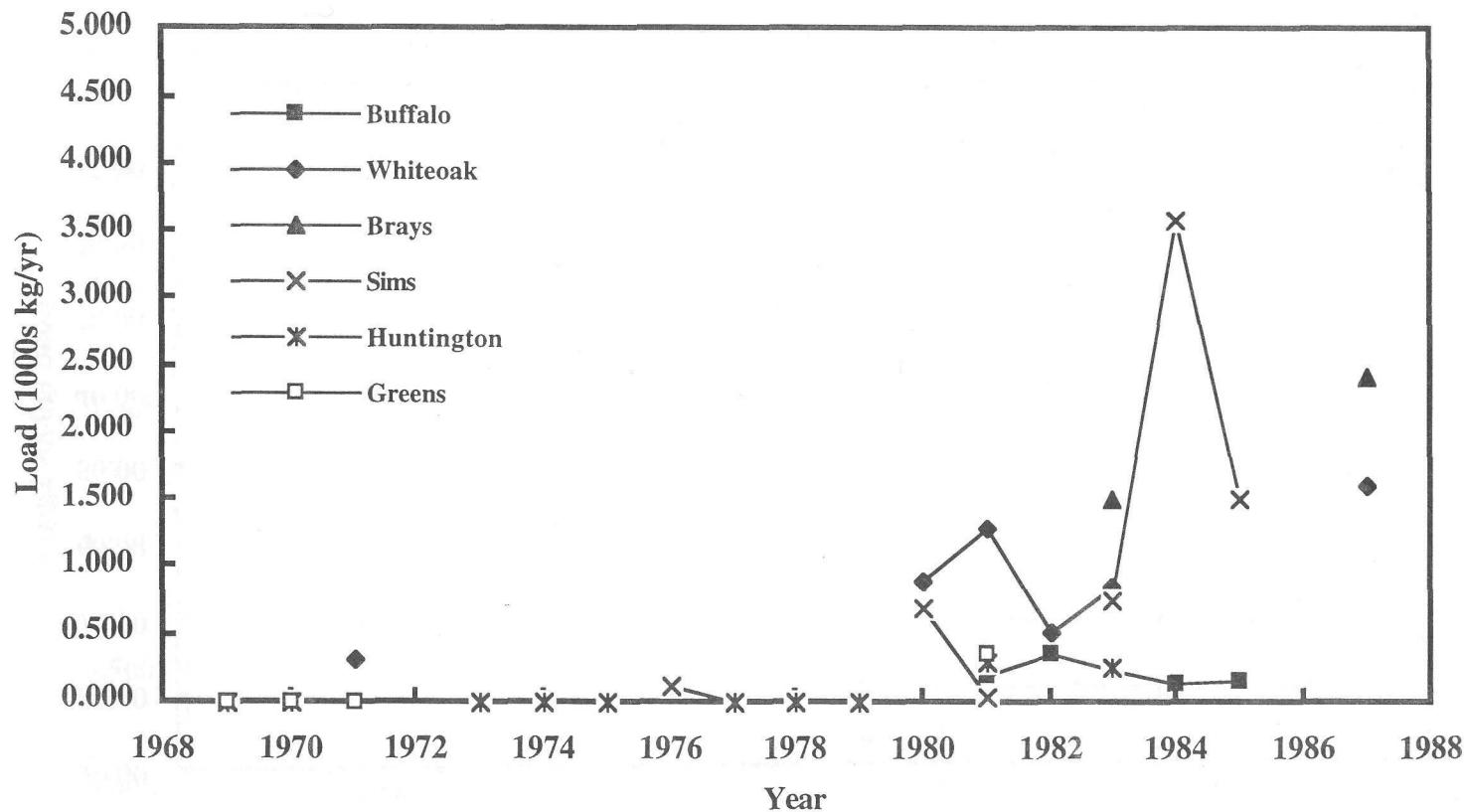


Figure 4.15 - Estimated Loads of Dissolved Copper into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988

Point Source Characterization Project  
Galveston Bay National Estuary Program

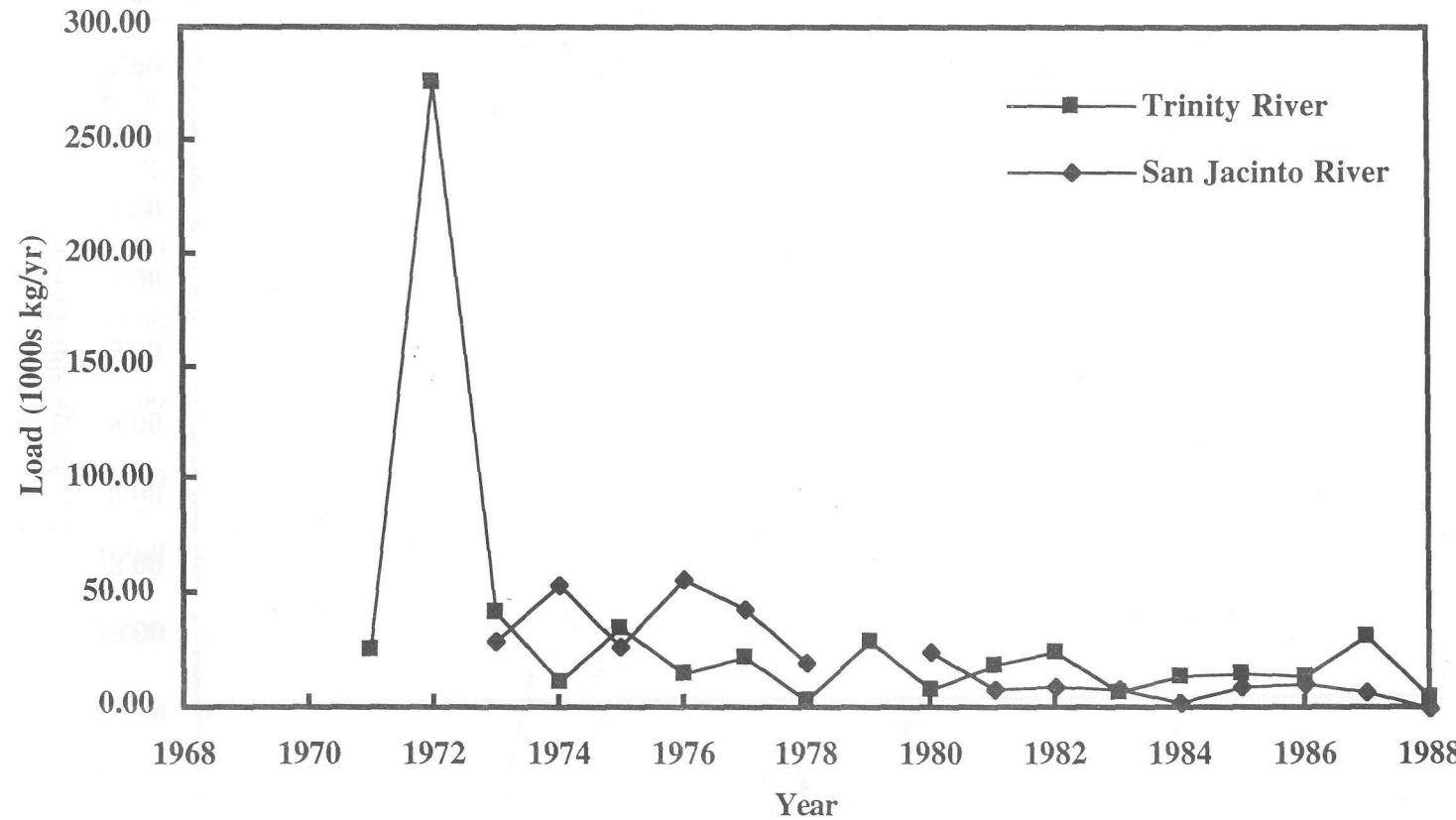


Figure 4.16 - Estimated Loads of Dissolved Copper into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

Point Source Characterization Project  
Galveston Bay National Estuary Program

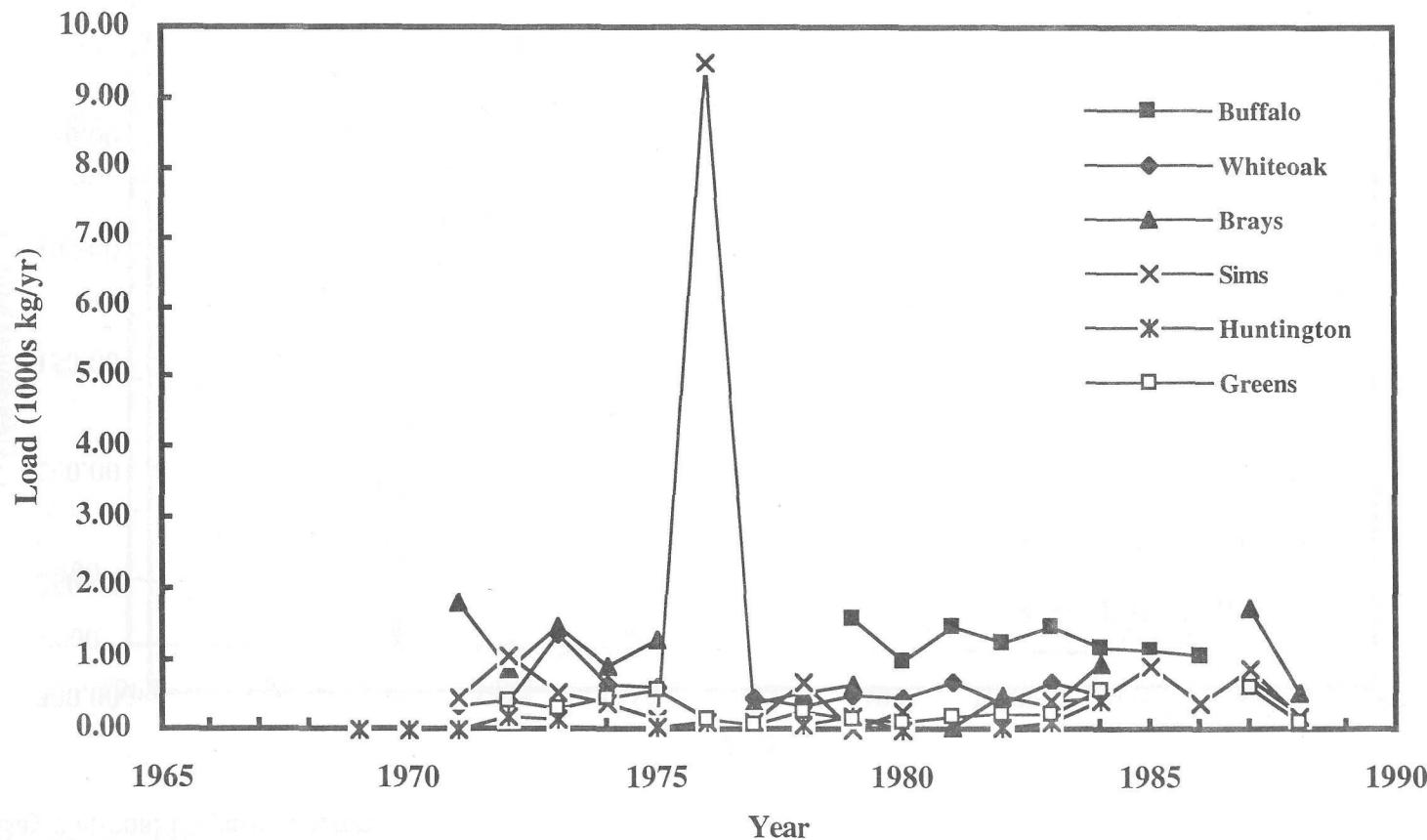


Figure 4.17 - Estimated Loads of Dissolved Iron into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988

Point Source Characterization Project  
Galveston Bay National Estuary Program

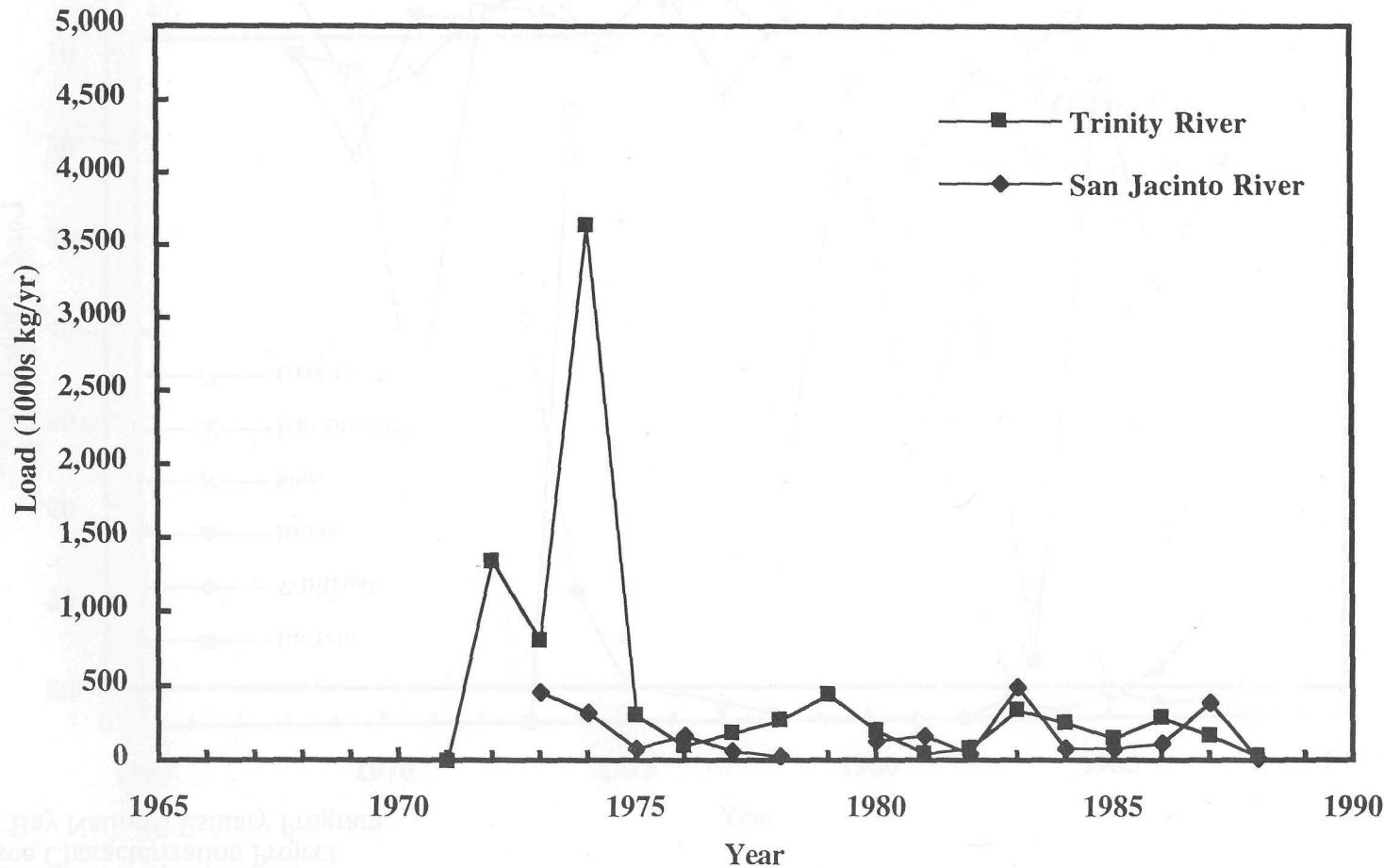
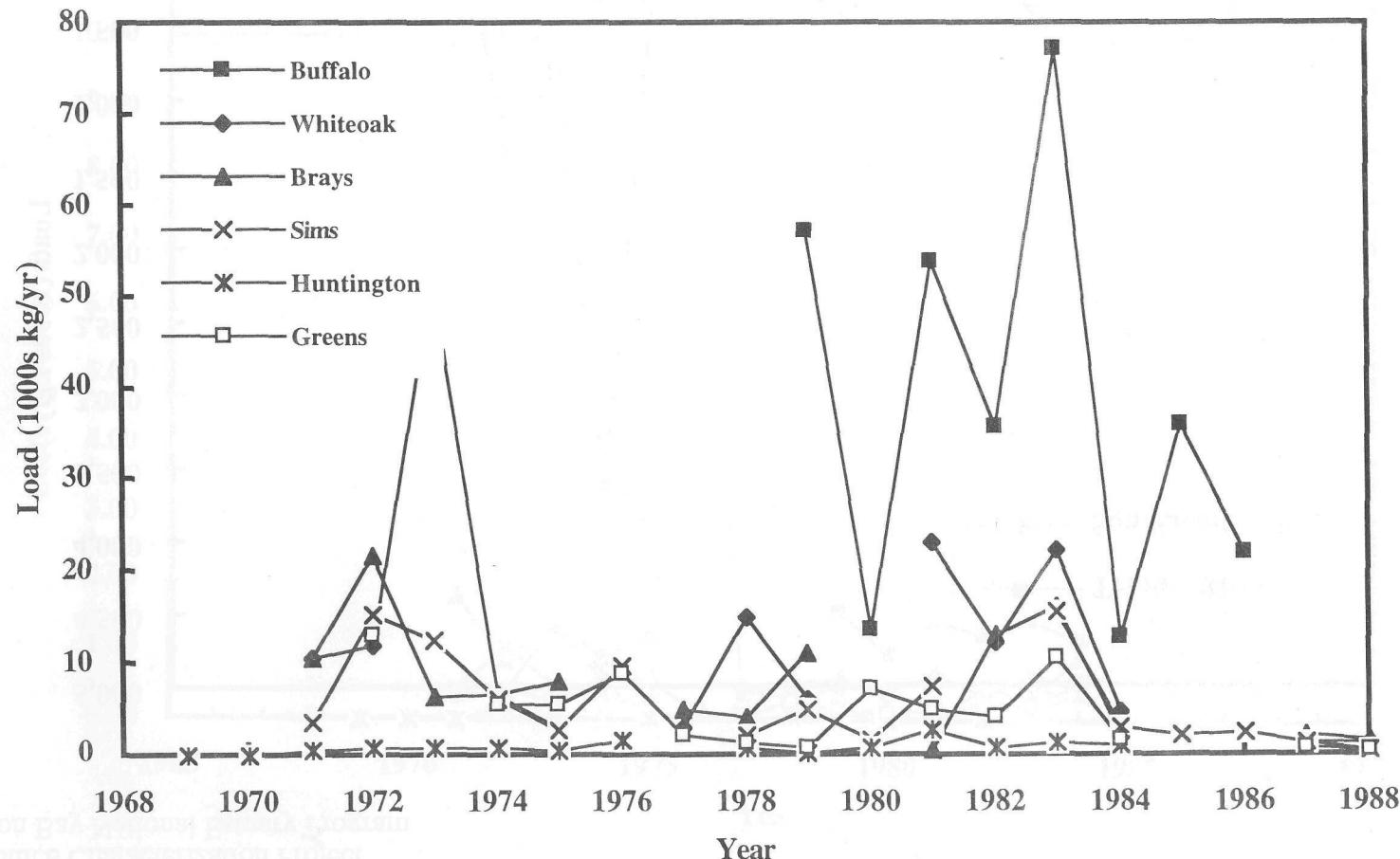


Figure 4.18 - Estimated Loads of Dissolved Iron into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

Point Source Characterization Project  
Galveston Bay National Estuary Program



**Figure 4.19 - Estimated Loads of Dissolved Lead into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988**

Point Source Characterization Project  
Galveston Bay National Estuary Program

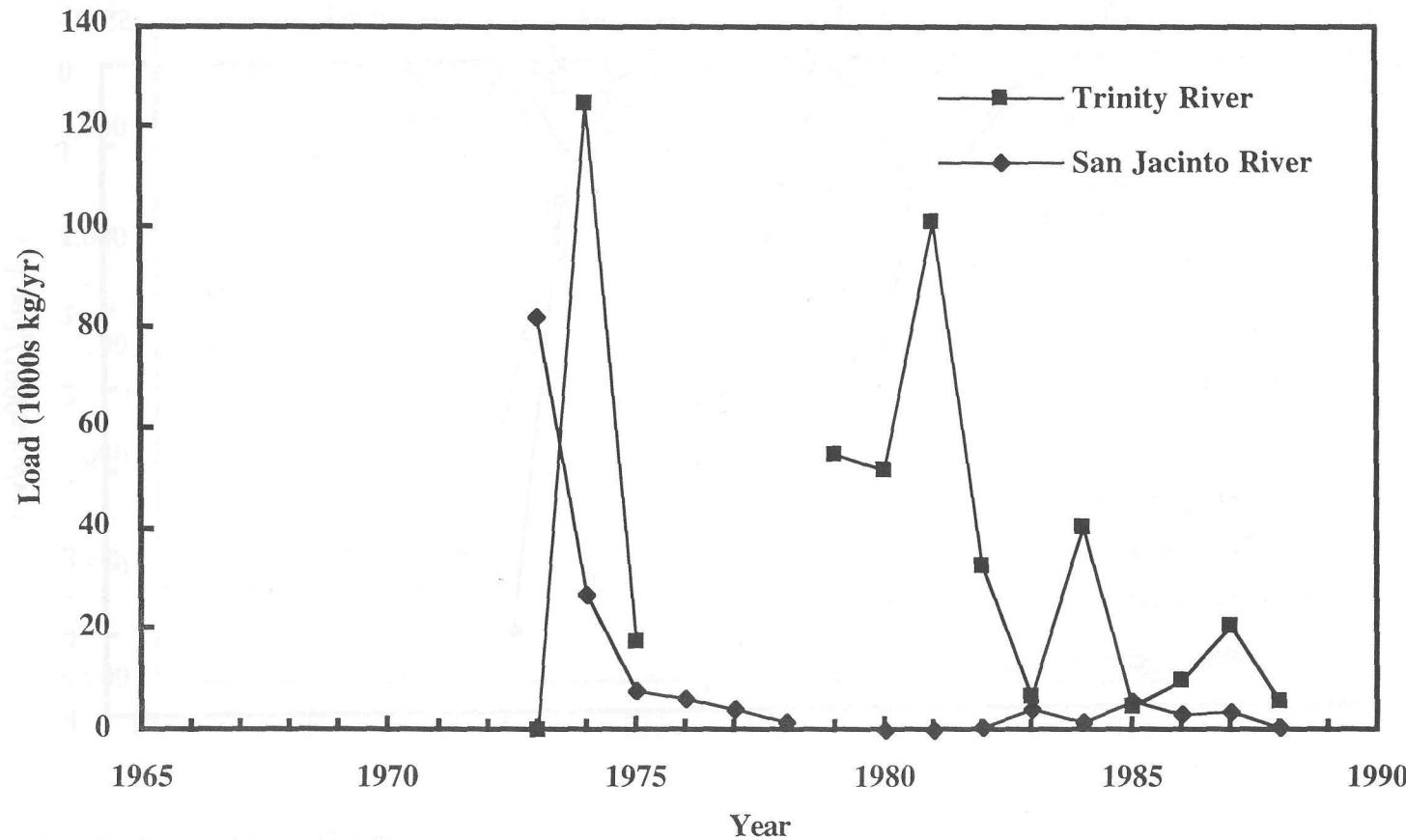
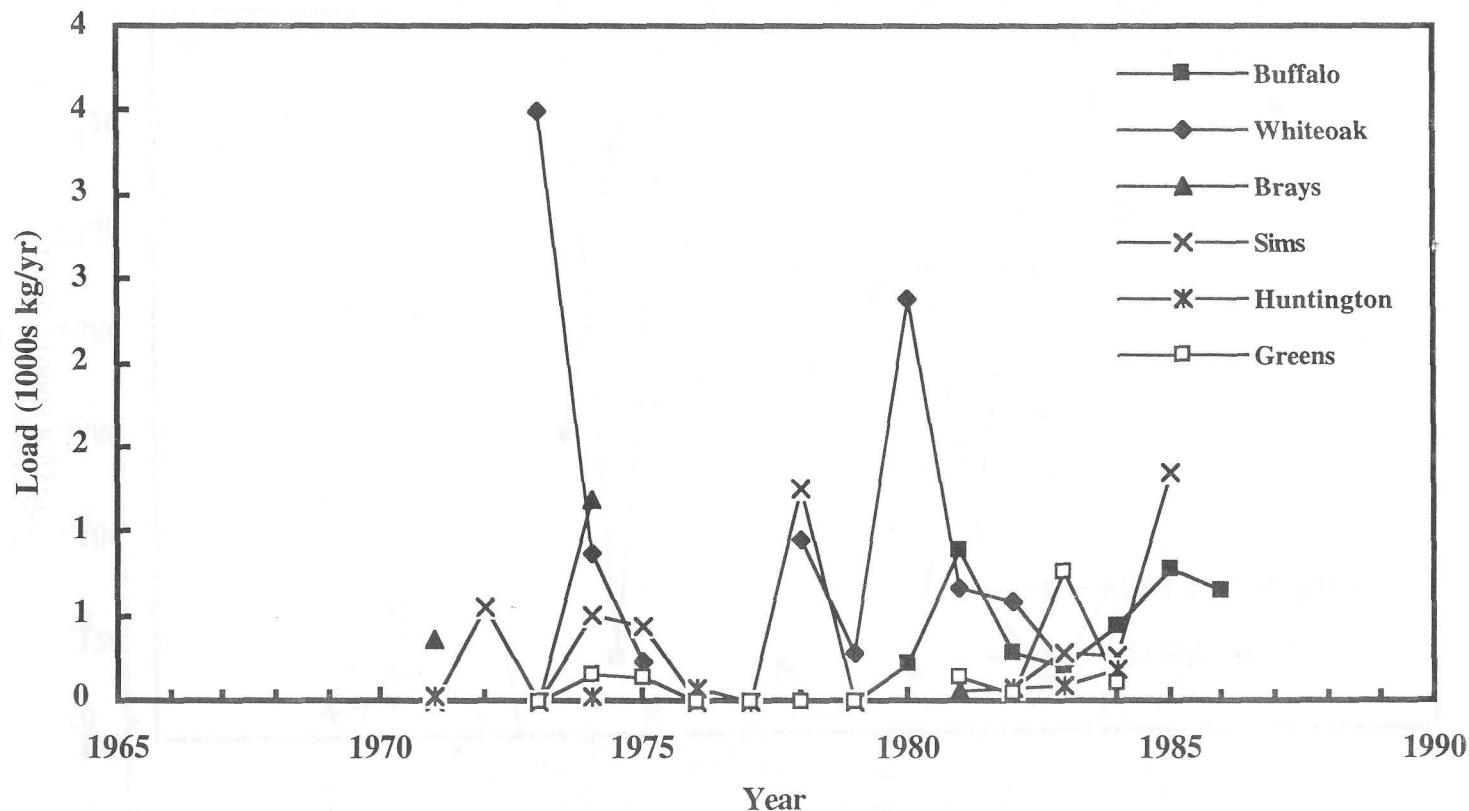


Figure 4.20 - Estimated Loads of Dissolved Lead into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

Point Source Characterization Project  
Galveston Bay National Estuary Program



**Figure 4.21 - Estimated Loads of Dissolved Mercury into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988**

Point Source Characterization Project  
Galveston Bay National Estuary Program

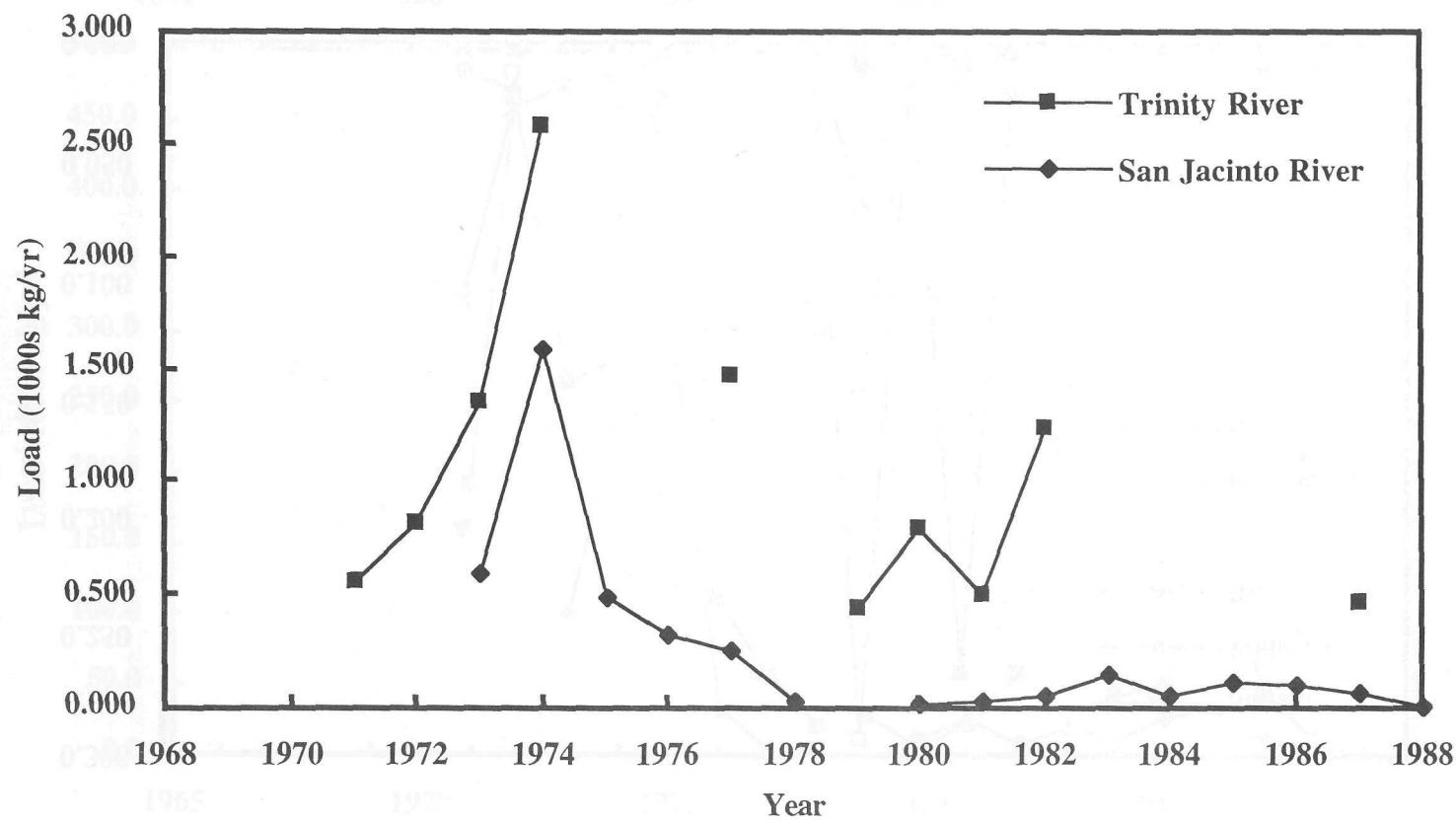
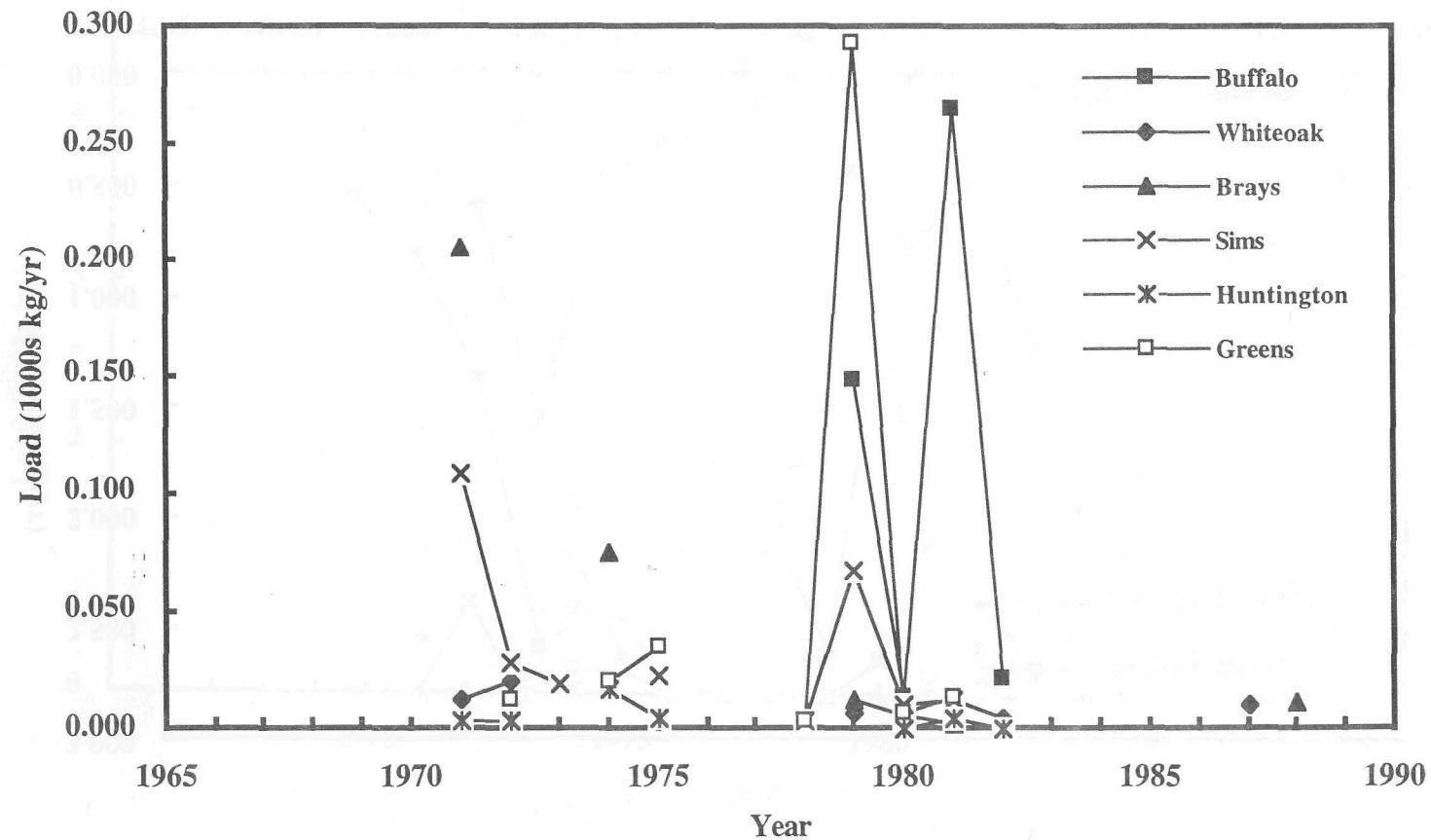


Figure 4.22 - Estimated Loads of Dissolved Mercury into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

Point Source Characterization Project  
Galveston Bay National Estuary Program



**Figure 4.23 - Estimated Loads of Dissolved Zinc into Galveston Bay from the Trinity River at Romayor and the San Jacinto River from 1969 through 1988**

Point Source Characterization Project  
Galveston Bay National Estuary Program

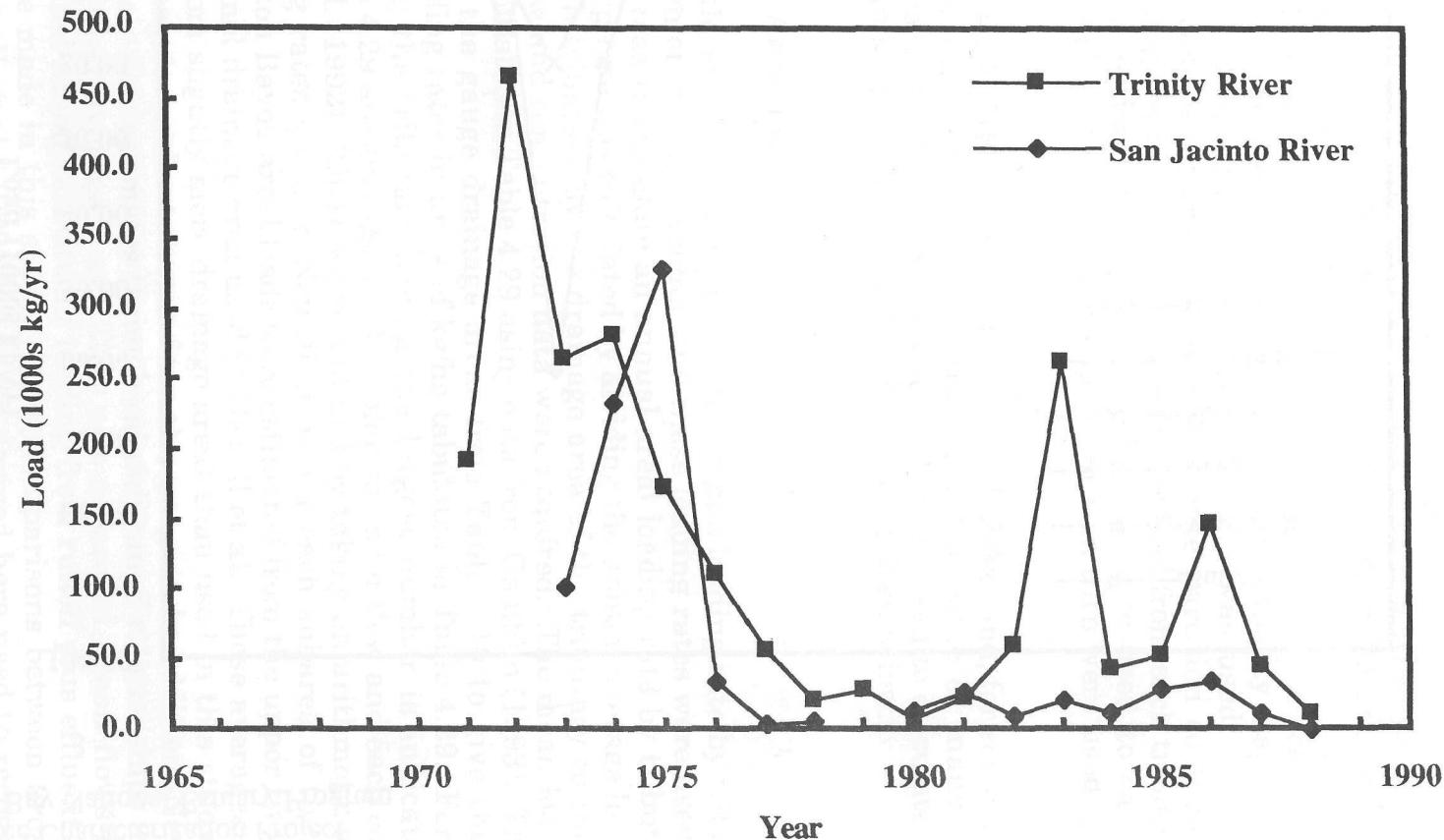
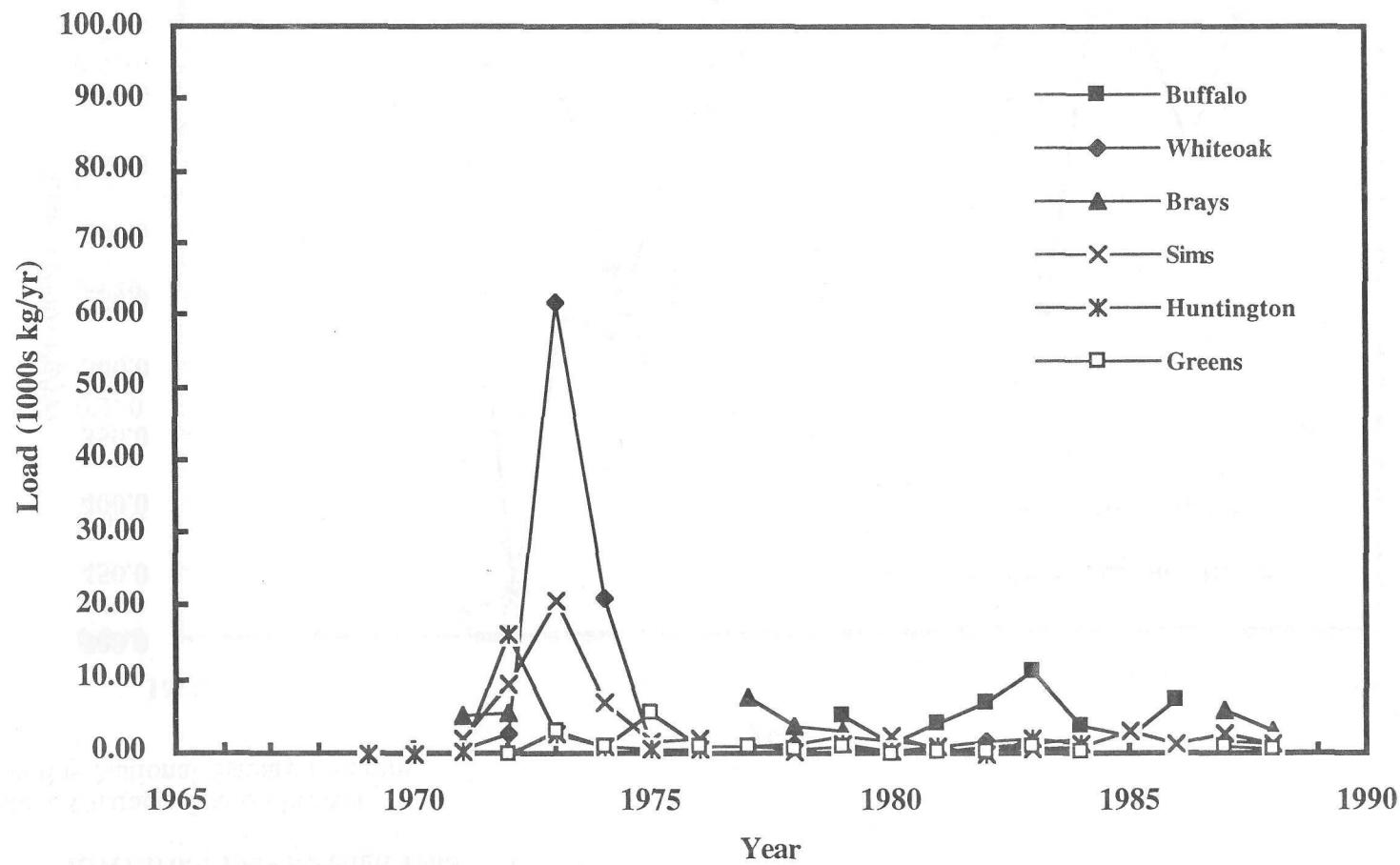


Figure 4.24 - Estimated Loads of Dissolved Zinc into Galveston Bay from Tributaries in the Houston Area from 1969 through 1988

Point Source Characterization Project  
Galveston Bay National Estuary Program



middle 1970s, respectively. Increases in loading in the early 1980s reversed that trend in the Trinity River, but the overall trend is evident. Tributary loads for dissolved zinc (Figure 4.24) also shown decreases in loads since the early 1970s.

Because the tributary loading rates for metals have been based on USGS data which measures metal concentrations in the dissolved phase, the metal loading data cannot be compared directly with the point source loading data derived from self-reporting data since metals are reported as total metal concentrations there. To convert the dissolved metal concentrations into total metal concentrations, the methodology employed to convert dissolved metal water quality standards to total metal concentrations and described in Section 3.2.3 was used. Average total suspended solids concentrations needed to calculate partition coefficients were calculated by dividing the average suspended solids load from each tributary by the average flow. The estimated partition coefficients were used to calculate the fractions of the metals in the dissolved phase which in turn were used to calculate total metal loads.

Table 4.28 contains all of the calculations described above, and, for some metals, the calculations show that total metal loadings are the same or many times the dissolved metal loadings. These total metal loads were used to calculate combined loadings from point source, rivers, and tributaries described below.

### **4.3.3 Spatial Analysis**

To analyze the differences among watersheds, a mean loading rate by tributary was calculated for each of the constituents, and these loading rates were used with the gauge drainage areas to calculate an annual areal loading rate by tributary. The mean areal loading rate was calculated by dividing the annual average load for each parameter in each tributary by the drainage area of the tributary to the gauging station where flow and concentration data were acquired. The mean loading rates calculated are tabulated in Table 4.29 using data from Gamblin (1993). These loads were divided by the gauge drainage areas from Table 3.10 to give the average annual areal loading rates in units of kg/ha tabulated in Table 4.29. For flow and each constituent, the tributary having the largest number is indicated. Also included in Table 4.29 are average areal loading rates for flow and each constituent from Newell et al. (1992). These were obtained by taking an arithmetic average of the areal loading rates given in Newell et al. for each subarea of the drainage basins. Huntington Bayou areal loads were estimated from the upper two subareas of the Ship Channel drainage area used in Newell et al. These averages represent areal loadings from slightly more drainage areas than used in this study, for they include the drainage area downstream from the gauges. In addition, Newell et al. (1992) derived their flow estimates through rainfall/runoff relationships using 1987 rainfall data for their average year. They also separated runoff flows from base flows and separated runoff constituent loading from runoff plus effluent discharge loads which were made in this study. Thus, comparisons between areal loading rates used in Newell et al. (1992) and those derived here need to recognize these differences.

**Table 4.28 - Metals Loading from Tributaries into Galveston Bay Corrected from Dissolved to Total Metal Loading**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Metal	Trinity River at Romayor 8066500 (kg/yr)	San Jacinto River 8072000 (kg/yr)	Buffalo Bayou 8073600 (kg/yr)	Whiteoak Bayou 8074500 (kg/yr)	Brays Bayou 8075000 (kg/yr)	Huntington Bayou 8075770 (kg/yr)	Sims Bayou 8075500 (kg/yr)	Greens Bayou 8076000 (kg/yr)	Bayou Totals (kg/yr)
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**Dissolved Forms**

Arsenic	20,919	1,885	844	770	2,294	602	215	478	5,203
Cadmium	4,204	728	620	104	151	15	92	81	1,063
Chromium	22,012	9,118	217	910	1,322	279	1,109	363	4,200
Copper	33,090	20,368	1,271	565	864	138	1,105	315	4,258
Iron	481,802	178,386	38,604	12,404	7,860	1,004	5,750	4,777	70,399
Lead	39,293	9,988	499	513	403	85	585	228	2,313
Mercury	1,025	262	112	12	52	5	34	55	270
Zinc	125,547	58,238	4,935	6,974	3,751	2,412	3,868	1,162	23,102

Avg. TSS (mg/L)	54.7	18.9	120.6	292.3	203.4	159.8	206.2	330.0
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**Partition Coef. (L/kg)**

Arsenic	25,998	56,391	14,614	7,667	9,986	11,905	9,887	7,019
Cadmium	43,343	144,133	17,729	6,515	9,818	12,897	9,667	5,680
Chromium	81,155	218,132	38,891	17,066	23,914	29,932	23,612	15,245
Copper	53,048	116,911	29,468	15,256	19,978	23,903	19,776	13,940
Iron	1	1	1	1	1	1	1	1
Lead	147,500	179,660	127,369	108,070	115,593	120,887	115,300	105,664
Mercury	30,920	103,358	12,598	4,610	6,959	9,152	6,852	4,017
Zinc	74,768	157,956	42,861	22,986	29,668	35,159	29,384	21,105

**Fraction Dissolved**

Arsenic	0.413	0.484	0.362	0.309	0.330	0.345	0.329	0.302
Cadmium	0.297	0.269	0.319	0.344	0.334	0.327	0.334	0.348
Chromium	0.184	0.195	0.176	0.167	0.171	0.173	0.170	0.166
Copper	0.256	0.312	0.220	0.183	0.197	0.207	0.197	0.179
Iron	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Lead	0.110	0.228	0.061	0.031	0.041	0.049	0.040	0.028
Mercury	0.372	0.339	0.397	0.426	0.414	0.406	0.414	0.430
Zinc	0.196	0.251	0.162	0.130	0.142	0.151	0.142	0.126

**Total Metals**

Arsenic	50,668	3,894	2,332	2,496	6,953	1,747	653	1,585	15,766
Cadmium	14,171	2,711	1,946	302	453	46	275	233	3,254
Chromium	119,727	46,709	1,235	5,449	7,752	1,613	6,508	2,189	24,748
Copper	129,108	65,373	5,788	3,085	4,375	665	5,611	1,764	21,288
Iron	481,828	178,389	38,609	12,408	7,862	1,004	5,751	4,779	70,412
Lead	356,319	43,903	8,164	16,718	9,878	1,727	14,493	8,178	59,159
Mercury	2,759	774	282	28	126	12	82	128	658
Zinc	639,010	232,100	30,444	53,831	26,386	15,964	27,304	9,255	163,184

**Table 4.29 - Annual Areal Tributary Loads**

Point Source Characterization Project  
Galveston Bay National Estuary Program

**ANNUAL LOADS**

		Buffalo Bayou	Whiteoak Bayou	Brays Bayou	Sims Bayou	Huntington Bayou	Greens Bayou
Drainage Area	ha	79,510.7	22,169.8	23,749.6	16,420.1	4,092.1	18,414.4
Runoff Volume	10 <sup>3</sup> acre-ft/yr	220	97	167	85	18	68
	MG/yr	71824	31,565	54,563	27,542	5,727	22,311
	cfs	305	134	231	117	24	95
BOD <sub>5</sub>	10 <sup>3</sup> kg/yr	1,450	1,289	1,416	876	253	610
TSS	10 <sup>3</sup> kg/yr	31,503	47,876	58,901	28,796	4,681	35,739
Total N	10 <sup>3</sup> kg/yr	1,113	330	633	403	107	219
Total P	10 <sup>3</sup> kg/yr	235	118	207	120	35	67
Oil & Grease	10 <sup>3</sup> kg/yr		1,441	859	8,063	647	1,095
Dissolved Arsenic	kg/yr	844	770	2,294	215	602	478
Dissolved Cadmium	kg/yr	620	104	151	92	15	81
Dissolved Chromium	kg/yr	217	910	1,322	1,109	279	363
Dissolved Copper	kg/yr	1,271	565	864	1,105	138	315
Dissolved Iron	kg/yr	38,604	12,404	7,860	5,750	1,004	4,777
Dissolved Lead	kg/yr	499	513	403	585	85	228
Dissolved Mercury	kg/yr	112	12	52	34	5	55
Dissolved Zinc	kg/yr	4,935	6,974	3,751	3,868	2,412	1,162

**ANNUAL AREAL LOADS**

Runoff Volume	acre-ft/ha yr	2.77	4.38	7.03	5.18	4.40	3.69
	MG/ha yr	0.90	1.42	2.30	1.68	1.40	1.21
	cfs/ha	0.0038	0.0060	0.0097	0.0071	0.0059	0.0052
BOD <sub>5</sub>	kg/ha yr	18.24	58.14	59.62	53.35	61.83	33.13
TSS	kg/ha yr	396.21	2,159.51	2,480.08	1,753.70	1,143.91	1,940.82
Total N	kg/ha yr	14.00	14.89	26.65	24.54	26.15	11.89
Total P	kg/ha yr	2.96	5.32	8.72	7.31	8.55	3.64
Oil & Grease	kg/ha yr	0.00	65.00	36.17	491.04	158.11	59.46
Dissolved Arsenic	kg/ha yr	0.011	0.035	0.097	0.013	0.147	0.026
Dissolved Cadmium	kg/ha yr	0.008	0.005	0.006	0.006	0.004	0.004
Dissolved Chromium	kg/ha yr	0.003	0.041	0.056	0.068	0.068	0.020
Dissolved Copper	kg/ha yr	0.016	0.025	0.036	0.067	0.034	0.017
Dissolved Iron	kg/ha yr	0.486	0.559	0.331	0.350	0.245	0.259
Dissolved Lead	kg/ha yr	0.006	0.023	0.017	0.036	0.021	0.012
Dissolved Mercury	kg/ha yr	0.001	0.001	0.002	0.002	0.001	0.003
Dissolved Zinc	kg/ha yr	0.062	0.315	0.158	0.236	0.589	0.063

**AREAL LOADING RATES FROM NEWELL ET AL. (1992)**

Runoff Volume	acre-ft/ha yr	1.46	5.77	6.19	5.54	12.22	9.99
	MG/ha yr						
	cfs/ha						
BOD <sub>5</sub>	kg/ha yr	57.4	56.1	52.2	40.8	55.1	38.9
TSS	kg/ha yr	896.2	881.2	882.7	680.4	859.0	553.8
Total N	kg/ha yr	13.9	13.6	12.8	10.1	13.3	9.2
Total P	kg/ha yr	2.67	2.59	2.38	1.77	2.48	1.70
Oil & Grease	kg/ha yr	57.5	52.2	53.4	34.3	55.6	25.0
Dissolved Arsenic	kg/ha yr						
Dissolved Cadmium	kg/ha yr						
Dissolved Chromium	kg/ha yr						
Dissolved Copper	kg/ha yr	0.018	0.018	0.018	0.015	0.019	0.013
Dissolved Iron	kg/ha yr						
Dissolved Lead	kg/ha yr						
Dissolved Mercury	kg/ha yr						
Dissolved Zinc	kg/ha yr						

Note: Highest areal load indicated by 

A cursory comparison of constituent areal loading rates between this study and Newell et al. (1992) indicates substantial differences. For conventional pollutants, Newell et al. (1992) found that Buffalo Bayou had the largest areal loading rates, while this study found that Brays and Huntington Bayous generally had the largest values. For the metals, Sims and Huntington Bayous had the largest values derived in this study while Newell et al (1992) found rather even areal loading rates in the Bayous with Huntington Bayou having the largest value. The differences in magnitudes of areal loading rates between the two studies suggest the need to isolate the effects of wastewater effluent from stormwater runoff in calculating areal loading rates from field data in the Houston area and to re-evaluate some of the estimated areal loading rates for the Buffalo Bayou drainage basin used by Newell et al. (1992).

#### 4.4 COMBINED LOADING

To put the loadings from point sources and major tributaries in perspective, tables have been prepared combining the two for the same constituents discussed in the point source section above. Comparison of contributions of flow are given in Tables 4.30 and 4.31; the reader should note that flows in the former table include cooling water flows while those in the latter do not. With the power plant cooling flows, a total of 3,498,330 MG/yr of waste discharges and tributary flows reaches the Galveston Bay system and just over 37 percent of that comes from discharges. Were the power plant cooling water flows removed from these flows, the percent contribution from wastewater discharges would be reduced to 7.4 percent of the total 2,362,766 MG/yr. Thus, tributary inflows dominate the flows into Galveston Bay, particularly when cooling water flows are not considered.

BOD<sub>5</sub> loadings from waste discharges and tributaries are given in Table 4.32, and from the category totals it is clear that the tributaries contribute overwhelmingly (almost 83 percent) the BOD<sub>5</sub> to the Galveston Bay system. While the BOD<sub>5</sub> contributions from the waste discharge category include only those discharges required to report BOD<sub>5</sub> discharges, these discharges include essentially all discharges with the exception of the cooling flows from power plants. These cooling flows are essentially recycling bay waters so even though they would contain small amounts of BOD<sub>5</sub> and coupled with the large flows would seem to be contributing large amounts of BOD<sub>5</sub> to the system, their net contribution is near zero. Of the tributaries, the Trinity River is the major contributor of BOD<sub>5</sub> to the Bay; in fact, the Trinity River almost three times as much BOD<sub>5</sub> to the Bay as wastewater discharges.

Like BOD<sub>5</sub>, the TSS contributions again come overwhelmingly (over 98 percent) from the major tributaries (Table 4.33). With TSS, like BOD, being a commonly reported constituent in waste discharges, the comparison of discharges and tributaries shows the importance of tributaries as a major source of constituents to the system.

Estimates of nutrient loadings from wastewater discharges and tributaries are given in Tables 4.34, and 4.35 for total nitrogen and total phosphorus, respectively.

**Table 4.30 - Flows from Waste Discharges (1990) and Tributaries (1968-88 Average) Including Cooling Water**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Flow (MG/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
Waste Discharges				
0801 - Trinity River Tidal	792	0.06	0.02	
0802 - Trinity River below Lake Livingston	349	0.03	0.01	
0901 - Cedar Bayou Tidal	2,075	0.16	0.06	
0902 - Cedar Bayou Above Tidal	312	0.02	0.01	
1001 - San Jacinto River Tidal	3,602	0.27	0.10	
1005 - Houston Ship Channel/San Jacinto R.	7,696	0.59	0.22	
1006 - Houston Ship Channel	63,844	4.87	1.82	
1007 - Houston Ship Channel/Buffalo Bayou	120,877	9.22	3.46	
1013 - Buffalo Bayou Tidal	6,629	0.51	0.19	
1014 - Buffalo Bayou Above Tidal	11,315	0.86	0.32	
1101 - Clear Creek Tidal	3,003	0.23	0.09	
1102 - Clear Creek Above Tidal	2,888	0.22	0.08	
1103 - Dickinson Bayou Tidal	1,002	0.08	0.03	
1104 - Dickinson Bayou Above Tidal	72	0.01	0.00	
1105 - Bastrop Bayou Tidal	121	0.01	0.00	
1107 - Chocolate Bayou Tidal	3,036	0.23	0.09	
1108 - Chocolate Bayou Above Tidal	18	0.00	0.00	
1113 - Armand Bayou Tidal	2,245	0.17	0.06	
2421 - Upper Galveston Bay	436,581	33.30	12.48	
2422 - Trinity Bay	417,649	31.85	11.94	
2423 - East Bay				
2424 - West Bay	2,038	0.16	0.06	
2425 - Clear Lake	115,422	8.80	3.30	
2426 - Tabbs Bay	1,408	0.11	0.04	
2427 - San Jacinto Bay	61,487	4.69	1.76	
2428 - Black Duck Bay				
2429 - Scott Bay	99	0.01	0.00	
2430 - Burnett Bay	5	0.00	0.00	
2431 - Moses Lake	2,338	0.18	0.07	
2432 - Chocolate Bay	986	0.08	0.03	
2433 - Bastrop Bay/Oyster Lake				
2434 - Christmas Bay				
2435 - Drum Bay				
2436 - Barbours Cut	21	0.00	0.00	
2437 - Texas City Ship Channel	4,718	0.36	0.13	
2438 - Bayport Channel	3,869	0.30	0.11	
2439 - Lower Galveston Bay	34,656	2.64	0.99	
Discharge Totals	1,311,151	100	37.48	37.48

Tributaries				
Trinity River at Romayor	1,619,551	74.05	46.29	
Buffalo Bayou at West Belt Dr.	71,824	3.28	2.05	
Whiteoak Bayou	31,565	1.44	0.90	
Brays Bayou	54,563	2.49	1.56	
Huntington Bayou at IH 610	5,727	0.26	0.16	
Sims Bayou	27,542	1.26	0.79	
Greens Bayou	22,311	1.02	0.64	
San Jacinto River at Lake Houston	354,096	16.19	10.12	
Tributary Totals	2,187,179	84	52.40	62.52
Grand Totals	3,498,330			100.00

**Table 4.31 - Flows from Waste Discharges (1990) and Tributaries (1968-88 Average) Excluding Cooling Water**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Flow (MG/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	792	0.45	0.03	
0802 - Trinity River below Lake Livingston	309	0.18	0.01	
0901 - Cedar Bayou Tidal	2,075	1.18	0.09	
0902 - Cedar Bayou Above Tidal	312	0.18	0.01	
1001 - San Jacinto River Tidal	3,602	2.05	0.15	
1005 - Houston Ship Channel/San Jacinto R.	7,696	4.38	0.33	
1006 - Houston Ship Channel	28,256	16.09	1.20	
1007 - Houston Ship Channel/Buffalo Bayou	79,329	45.18	3.36	
1013 - Buffalo Bayou Tidal	6,629	3.78	0.28	
1014 - Buffalo Bayou Above Tidal	11,315	6.44	0.48	
1101 - Clear Creek Tidal	3,003	1.71	0.13	
1102 - Clear Creek Above Tidal	2,888	1.64	0.12	
1103 - Dickinson Bayou Tidal	983	0.56	0.04	
1104 - Dickinson Bayou Above Tidal	72	0.04	0.00	
1105 - Bastrop Bayou Tidal	121	0.07	0.01	
1107 - Chocolate Bayou Tidal	3,036	1.73	0.13	
1108 - Chocolate Bayou Above Tidal	18	0.01	0.00	
1113 - Armand Bayou Tidal	2,245	1.28	0.10	
2421 - Upper Galveston Bay	2,180	1.24	0.09	
2422 - Trinity Bay	195	0.11	0.01	
2423 - East Bay				
2424 - West Bay	2,038	1.16	0.09	
2425 - Clear Lake	163	0.09	0.01	
2426 - Tabbs Bay	1,408	0.80	0.06	
2427 - San Jacinto Bay	3,432	1.95	0.15	
2428 - Black Duck Bay				
2429 - Scott Bay	99	0.06	0.00	
2430 - Burnett Bay	5	0.00	0.00	
2431 - Moses Lake	2,338	1.33	0.10	
2432 - Chocolate Bay	986	0.56	0.04	
2433 - Bastrop Bay/Oyster Lake				
2434 - Christmas Bay				
2435 - Drum Bay				
2436 - Barbours Cut	21	0.01	0.00	
2437 - Texas City Ship Channel	4,718	2.69	0.20	
2438 - Bayport Channel	3,869	2.20	0.16	
2439 - Lower Galveston Bay	1,457	0.83	0.06	
<b>Discharge Totals</b>	<b>175,587</b>	<b>100</b>	<b>7.43</b>	<b>7.43</b>

Tributaries				
Trinity River at Romayor	1,619,551	74.05	68.54	
Buffalo Bayou at West Belt Dr.	71,824	3.28	3.04	
Whiteoak Bayou	31,565	1.44	1.34	
Brays Bayou	54,563	2.49	2.31	
Huntington Bayou at IH 610	5,727	0.26	0.24	
Sims Bayou	27,542	1.26	1.17	
Greens Bayou	22,311	1.02	0.94	
San Jacinto River at Lake Houston	354,096	16.19	14.99	

Tributary Totals	2,187,179	84	77.58	92.57
Grand Totals	2,362,766			100.00

**Table 4.32 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for BOD<sub>5</sub>**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	17,837	0.38	0.07	
0802 - Trinity River below Lake Livingston	18,625	0.40	0.07	
0901 - Cedar Bayou Tidal	45,988	0.99	0.17	
0902 - Cedar Bayou Above Tidal	6,535	0.14	0.02	
1001 - San Jacinto River Tidal	86,073	1.85	0.32	
1005 - Houston Ship Channel/San Jacinto R.	633,859	13.62	2.34	
1006 - Houston Ship Channel	955,194	20.52	3.53	
1007 - Houston Ship Channel/Buffalo Bayou	1,504,392	32.32	5.55	
1013 - Buffalo Bayou Tidal	71,622	1.54	0.26	
1014 - Buffalo Bayou Above Tidal	102,585	2.20	0.38	
1101 - Clear Creek Tidal	27,581	0.59	0.10	
1102 - Clear Creek Above Tidal	33,464	0.72	0.12	
1103 - Dickinson Bayou Tidal	22,173	0.48	0.08	
1104 - Dickinson Bayou Above Tidal	594	0.01	0.00	
1105 - Bastrop Bayou Tidal	4,094	0.09	0.02	
1107 - Chocolate Bayou Tidal	106,302	2.28	0.39	
1108 - Chocolate Bayou Above Tidal	480	0.01	0.00	
1113 - Armand Bayou Tidal	17,838	0.38	0.07	
2421 - Upper Galveston Bay	34,137	0.73	0.13	
2422 - Trinity Bay	2,714	0.06	0.01	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	23,958	0.51	0.09	
2425 - Clear Lake	1,367	0.03	0.01	
2426 - Tabbs Bay	25,163	0.54	0.09	
2427 - San Jacinto Bay	57,348	1.23	0.21	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	209	0.00	0.00	
2430 - Burnett Bay	330	0.01	0.00	
2431 - Moses Lake	75,788	1.63	0.28	
2432 - Chocolate Bay	15,148	0.33	0.06	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	217	0.00	0.00	
2437 - Texas City Ship Channel	452,954	9.73	1.67	
2438 - Bayport Channel	164,470	3.53	0.61	
2439 - Lower Galveston Bay	145,514	3.13	0.54	
Discharge Totals	4,654,554	100	17.19	17.19

Tributaries				
Trinity River at Romayor	12,975,760	57.85	47.91	
Buffalo Bayou at West Belt Dr.	1,499,526	6.69	5.54	
Whiteoak Bayou	1,288,525	5.74	4.76	
Brays Bayou	1,415,877	6.31	5.23	
Huntington Bayou at IH 610	252,523	1.13	0.93	
Sims Bayou	875,502	3.90	3.23	
Greens Bayou	609,741	2.72	2.25	
San Jacinto River at Lake Houston	3,512,396	15.66	12.97	

Tributary Totals	22,429,850	100	82.81	82.81
Grand Totals	27,084,404			100.00

**Table 4.33 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Suspended Solids**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	46,303	0.48	0.01	
0802 - Trinity River below Lake Livingston	73,485	0.76	0.01	
0901 - Cedar Bayou Tidal	66,725	0.69	0.01	
0902 - Cedar Bayou Above Tidal	17,102	0.18	0.00	
1001 - San Jacinto River Tidal	213,693	2.20	0.03	
1005 - Houston Ship Channel/San Jacinto R.	876,359	9.03	0.14	
1006 - Houston Ship Channel	2,156,212	22.22	0.34	
1007 - Houston Ship Channel/Buffalo Bayou	3,542,507	36.50	0.55	
1013 - Buffalo Bayou Tidal	123,759	1.28	0.02	
1014 - Buffalo Bayou Above Tidal	190,184	1.96	0.03	
1101 - Clear Creek Tidal	27,951	0.29	0.00	
1102 - Clear Creek Above Tidal	35,820	0.37	0.01	
1103 - Dickinson Bayou Tidal	12,981	0.13	0.00	
1104 - Dickinson Bayou Above Tidal	1,630	0.02	0.00	
1105 - Bastrop Bayou Tidal	4,622	0.05	0.00	
1107 - Chocolate Bayou Tidal	339,483	3.50	0.05	
1108 - Chocolate Bayou Above Tidal	850	0.01	0.00	
1113 - Armand Bayou Tidal	17,840	0.18	0.00	
2421 - Upper Galveston Bay	48,281	0.50	0.01	
2422 - Trinity Bay	5,145	0.05	0.00	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	26,802	0.28	0.00	
2425 - Clear Lake	2,737	0.03	0.00	
2426 - Tabbs Bay	37,715	0.39	0.01	
2427 - San Jacinto Bay	234,476	2.42	0.04	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	3,924	0.04	0.00	
2430 - Burnett Bay	721	0.01	0.00	
2431 - Moses Lake	97,906	1.01	0.02	
2432 - Chocolate Bay	37,364	0.39	0.01	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	1,550	0.02	0.00	
2437 - Texas City Ship Channel	845,571	8.71	0.13	
2438 - Bayport Channel	400,664	4.13	0.06	
2439 - Lower Galveston Bay	214,103	2.21	0.03	
<b>Discharge Totals</b>	<b>9,704,464</b>	<b>100</b>	<b>1.51</b>	<b>1.51</b>

<b>Tributaries</b>				
Trinity River at Romayor	398,456,216	63.11	62.16	
Buffalo Bayou at West Belt Dr.	31,502,478	4.99	4.91	
Whiteoak Bayou	47,875,911	7.58	7.47	
Brays Bayou	58,901,379	9.33	9.19	
Huntington Bayou at IH 610	4,680,512	0.74	0.73	
Sims Bayou	28,796,087	4.56	4.49	
Greens Bayou	35,738,886	5.66	5.57	
San Jacinto River at Lake Houston	25,405,921	4.02	3.96	
<b>Tributary Totals</b>	<b>631,357,390</b>	<b>100</b>	<b>98.49</b>	<b>98.49</b>
<b>Grand Totals</b>	<b>641,061,854</b>			<b>100.00</b>

**Table 4.34 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Nitrogen**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	41,900	0.50	0.20	
0802 - Trinity River below Lake Livingston	15,848	0.19	0.08	
0901 - Cedar Bayou Tidal	82,368	0.98	0.39	
0902 - Cedar Bayou Above Tidal	30,647	0.36	0.15	
1001 - San Jacinto River Tidal	64,564	0.77	0.31	
1005 - Houston Ship Channel/San Jacinto R.	436,953	5.19	2.09	
1006 - Houston Ship Channel	1,356,365	16.10	6.48	
1007 - Houston Ship Channel/Buffalo Bayou	4,071,864	48.33	19.47	
1013 - Buffalo Bayou Tidal	350,665	4.16	1.68	
1014 - Buffalo Bayou Above Tidal	596,023	7.07	2.85	
1101 - Clear Creek Tidal	159,039	1.89	0.76	
1102 - Clear Creek Above Tidal	152,939	1.82	0.73	
1103 - Dickinson Bayou Tidal	52,042	0.62	0.25	
1104 - Dickinson Bayou Above Tidal	3,811	0.05	0.02	
1105 - Bastrop Bayou Tidal	6,392	0.08	0.03	
1107 - Chocolate Bayou Tidal	512	0.01	0.00	
1108 - Chocolate Bayou Above Tidal	845	0.01	0.00	
1113 - Armand Bayou Tidal	118,895	1.41	0.57	
2421 - Upper Galveston Bay	119,280	1.42	0.57	
2422 - Trinity Bay	10,309	0.12	0.05	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	107,949	1.28	0.52	
2425 - Clear Lake	8,391	0.10	0.04	
2426 - Tabbs Bay	74,275	0.88	0.36	
2427 - San Jacinto Bay	67,025	0.80	0.32	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	5,220	0.06	0.02	
2430 - Burnett Bay	211	0.00	0.00	
2431 - Moses Lake	123,806	1.47	0.59	
2432 - Chocolate Bay	52,201	0.62	0.25	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	1,106	0.01	0.01	
2437 - Texas City Ship Channel	237,832	2.82	1.14	
2438 - Bayport Channel	0	0.00	0.00	
2439 - Lower Galveston Bay	76,193	0.90	0.36	
Discharge Totals	8,425,474	100	40.28	40.28

Tributaries				
Trinity River at Romayor	8,160,624	65.33	39.01	
Buffalo Bayou at West Belt Dr.	1,112,640	8.91	5.32	
Whiteoak Bayou	330,078	2.64	1.58	
Brays Bayou	632,602	5.06	3.02	
Huntington Bayou at IH 610	106,876	0.86	0.51	
Sims Bayou	403,261	3.23	1.93	
Greens Bayou	218,997	1.75	1.05	
San Jacinto River at Lake Houston	1,526,219	12.22	7.30	

Tributary Totals	12,491,297	100	59.72	59.72
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Grand Totals	20,916,771			100.00
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**Table 4.35 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Phosphorus**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
Waste Discharges				
0801 - Trinity River Tidal	20,974	0.52	0.33	
0802 - Trinity River below Lake Livingston	7,924	0.20	0.13	
0901 - Cedar Bayou Tidal	29,213	0.73	0.46	
0902 - Cedar Bayou Above Tidal	3,151	0.08	0.05	
1001 - San Jacinto River Tidal	32,282	0.81	0.51	
1005 - Houston Ship Channel/San Jacinto R.	184,747	4.62	2.93	
1006 - Houston Ship Channel	488,170	12.20	7.74	
1007 - Houston Ship Channel/Buffalo Bayou	2,035,884	50.86	32.28	
1013 - Buffalo Bayou Tidal	175,338	4.38	2.78	
1014 - Buffalo Bayou Above Tidal	298,002	7.45	4.72	
1101 - Clear Creek Tidal	79,520	1.99	1.26	
1102 - Clear Creek Above Tidal	76,469	1.91	1.21	
1103 - Dickinson Bayou Tidal	26,021	0.65	0.41	
1104 - Dickinson Bayou Above Tidal	1,906	0.05	0.03	
1105 - Bastrop Bayou Tidal	3,196	0.08	0.05	
1107 - Chocolate Bayou Tidal	256	0.01	0.00	
1108 - Chocolate Bayou Above Tidal	428	0.01	0.01	
1113 - Armand Bayou Tidal	59,447	1.49	0.94	
2421 - Upper Galveston Bay	60,533	1.51	0.96	
2422 - Trinity Bay	5,155	0.13	0.08	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	53,974	1.35	0.86	
2425 - Clear Lake	4,325	0.11	0.07	
2426 - Tabbs Bay	37,195	0.93	0.59	
2427 - San Jacinto Bay	6,694	0.17	0.11	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	2,610	0.07	0.04	
2430 - Burnett Bay	132	0.00	0.00	
2431 - Moses Lake	61,903	1.55	0.98	
2432 - Chocolate Bay	26,100	0.65	0.41	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	553	0.01	0.01	
2437 - Texas City Ship Channel	182,467	4.56	2.89	
2438 - Bayport Channel	0	0.00	0.00	
2439 - Lower Galveston Bay	38,097	0.95	0.60	
Discharge Totals	4,002,666	100	63.46	63.46

Tributaries				
Trinity River at Romayor	1,334,538	57.91	21.16	
Buffalo Bayou at West Belt Dr.	234,693	10.18	3.72	
Whiteoak Bayou	117,922	5.12	1.87	
Brays Bayou	206,702	8.97	3.28	
Huntington Bayou at IH 610	34,463	1.50	0.55	
Sims Bayou	120,383	5.22	1.91	
Greens Bayou	67,222	2.92	1.07	
San Jacinto River at Lake Houston	188,392	8.18	2.99	

Tributary Totals	2,304,315	100	36.54	36.54
Grand Totals	6,306,981		100.00	

Total nitrogen loads from all sources is estimated to total 20,916,771 kg/yr with about 60 percent of that being contributed by the major tributaries, mainly the Trinity River. Total phosphorus loads total 6,306,981 kg/yr with about 63 percent of the total derived from wastewater discharges.

Oil and grease discharges with wastewaters was shown earlier to be mainly from municipal wastewaters based entirely on TPCs. As shown in Table 4.36, it reaches the Galveston Bay system primarily through the tributaries. The percentages are heavily weighted toward the tributaries even with no data from the Trinity River, Buffalo Bayou, and the San Jacinto River.

Fecal coliform contributions to the Bay system are estimated to total  $162.3 \times 10^{15}$  colonies/yr as seen in Table 4.37, and the vast majority of these originate from the major tributaries. For this constituent, the tributary loads are taken from Newell et al. (1992) and are based on an average year rainfall (1987) which was thought to approximate the long term average loads used herein for the other constituents. If the single large point source contribution was removed from the point source total, the tributaries would contribute over 99 percent of the total.

Because the USGS measures metal concentrations in the dissolved form, the loadings for metals based on those concentrations had to be converted to the total metal form so they would be comparable with the loads from the wastewater discharges. With these total metals loads for the tributaries given in Table 4.28 and compared to point source loadings, it is clear that all of the metals are loaded primarily from the tributaries. Tables 4.38 through 4.45 show the overwhelming percent contributions from the tributaries for arsenic (77.8 percent), cadmium (75.9 percent), total chromium (85.6 percent), copper (88.5 percent), iron (63.3 percent), lead (94.8 percent), mercury (98.6 percent), and zinc (90.1 percent). These percentages change only for copper (89.6 percent) and zinc (90.4 percent) with the revised TPCs.

The only organic substance which could be compared between the waste discharge category and tributaries was PCBs, and again the tributaries dominated the contributions with 86.4 percent of the total (Table 4.46).

#### **4.5 BRINE DISCHARGES**

Permitted brine discharges listed by the Underground Injection Control group in the Texas Railroad Commission as of May 1992 are listed in Table 4.47. Most of the 51 discharges are in the upper portions of Galveston Bay, namely Trinity Bay (16) and Tabbs Bay (10). Some 192,373 bbl/day (2,949.1 MG/yr) were discharged at that time. The composition of these discharges was unknown thus a loading of TDS could not be calculated. Of the 16 discharges to Trinity Bay, there were four large discharges totaling about 2,000 MG/yr, and the discharges to Tabbs Bay approached 400 MG/yr. In terms of quantity of discharge, these two bays appeared to receive the bulk of the brine discharge.

**Table 4.36 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Oil and Grease**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	33,505	0.53	0.18	
0802 - Trinity River below Lake Livingston	12,759	0.20	0.07	
0901 - Cedar Bayou Tidal	41,462	0.66	0.23	
0902 - Cedar Bayou Above Tidal	7,280	0.12	0.04	
1001 - San Jacinto River Tidal	72,956	1.16	0.40	
1005 - Houston Ship Channel/San Jacinto R.	59,498	0.95	0.32	
1006 - Houston Ship Channel	815,110	12.98	4.43	
1007 - Houston Ship Channel/Buffalo Bayou	3,429,581	54.59	18.65	
1013 - Buffalo Bayou Tidal	280,535	4.47	1.53	
1014 - Buffalo Bayou Above Tidal	477,166	7.60	2.60	
1101 - Clear Creek Tidal	127,232	2.03	0.69	
1102 - Clear Creek Above Tidal	122,351	1.95	0.67	
1103 - Dickinson Bayou Tidal	48,125	0.77	0.26	
1104 - Dickinson Bayou Above Tidal	3,049	0.05	0.02	
1105 - Bastrop Bayou Tidal	5,113	0.08	0.03	
1107 - Chocolate Bayou Tidal	410	0.01	0.00	
1108 - Chocolate Bayou Above Tidal	645	0.01	0.00	
1113 - Armand Bayou Tidal	95,116	1.51	0.52	
2421 - Upper Galveston Bay	92,113	1.47	0.50	
2422 - Trinity Bay	8,247	0.13	0.04	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	86,356	1.37	0.47	
2425 - Clear Lake	6,145	0.10	0.03	
2426 - Tabbs Bay	59,176	0.94	0.32	
2427 - San Jacinto Bay	7,827	0.12	0.04	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	585	0.01	0.00	
2430 - Burnett Bay	275	0.00	0.00	
2431 - Moses Lake	96,047	1.53	0.52	
2432 - Chocolate Bay	41,760	0.66	0.23	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	885	0.01	0.00	
2437 - Texas City Ship Channel	48,267	0.77	0.26	
2438 - Bayport Channel	80,130	1.28	0.44	
2439 - Lower Galveston Bay	122,436	1.95	0.67	
Discharge Totals	6,282,142	100	34.17	34.17

Tributaries				
Trinity River at Romayor		0.00	0.00	
Buffalo Bayou at West Belt Dr.		0.00	0.00	
Whiteoak Bayou	1,441,271	11.91	7.84	
Brays Bayou	858,577	7.09	4.67	
Huntington Bayou at IH 610	647,279	5.35	3.52	
Sims Bayou	8,063,014	66.61	43.85	
Greens Bayou	1,095,002	9.05	5.96	
San Jacinto River at Lake Houston		0.00	0.00	

Tributary Totals	12,105,143	100	65.83	65.83
Grand Totals	18,387,285			100.00

**Table 4.37 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Fecal Coliform Bacteria**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (10 <sup>15</sup> Col./yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
Waste Discharges				
0801 - Trinity River Tidal	0.0060	0.23	0.00	
0802 - Trinity River below Lake Livingston	0.0023	0.09	0.00	
0901 - Cedar Bayou Tidal	0.0084	0.32	0.01	
0902 - Cedar Bayou Above Tidal	0.0009	0.03	0.00	
1001 - San Jacinto River Tidal	0.0092	0.36	0.01	
1005 - Houston Ship Channel/San Jacinto R.	0.0528	2.04	0.03	
1006 - Houston Ship Channel	0.1395	5.38	0.09	
1007 - Houston Ship Channel/Buffalo Bayou	2.0381	78.66	1.26	
1013 - Buffalo Bayou Tidal	0.0501	1.93	0.03	
1014 - Buffalo Bayou Above Tidal	0.0852	3.29	0.05	
1101 - Clear Creek Tidal	0.0227	0.88	0.01	
1102 - Clear Creek Above Tidal	0.0219	0.84	0.01	
1103 - Dickinson Bayou Tidal	0.0074	0.29	0.00	
1104 - Dickinson Bayou Above Tidal	0.0005	0.02	0.00	
1105 - Bastrop Bayou Tidal	0.0009	0.04	0.00	
1107 - Chocolate Bayou Tidal	0.0001	0.00	0.00	
1108 - Chocolate Bayou Above Tidal	0.0001	0.00	0.00	
1113 - Armand Bayou Tidal	0.0170	0.66	0.01	
2421 - Upper Galveston Bay	0.0173	0.67	0.01	
2422 - Trinity Bay	0.0015	0.06	0.00	
2423 - East Bay	0.0000	0.00	0.00	
2424 - West Bay	0.0154	0.60	0.01	
2425 - Clear Lake	0.0012	0.05	0.00	
2426 - Tabbs Bay	0.0106	0.41	0.01	
2427 - San Jacinto Bay	0.0014	0.05	0.00	
2428 - Black Duck Bay	0.0000	0.00	0.00	
2429 - Scott Bay	0.0007	0.03	0.00	
2430 - Burnett Bay	0.0000	0.00	0.00	
2431 - Moses Lake	0.0177	0.68	0.01	
2432 - Chocolate Bay	0.0075	0.29	0.00	
2433 - Bastrop Bay/Oyster Lake	0.0000	0.00	0.00	
2434 - Christmas Bay	0.0000	0.00	0.00	
2435 - Drum Bay	0.0000	0.00	0.00	
2436 - Barbours Cut	0.0002	0.01	0.00	
2437 - Texas City Ship Channel	0.0281	1.08	0.02	
2438 - Bayport Channel	0.0000	0.00	0.00	
2439 - Lower Galveston Bay	0.0263	1.02	0.02	
Discharge Totals	2.5911	100.00	1.60	1.60

Tributaries*				
Trinity River at Romayor	1.10	0.69	0.68	
Buffalo Bayou at West Belt Dr.	27.0	16.91	16.64	
Whiteoak Bayou	29.0	18.16	17.87	
Brays Bayou	34.0	21.29	20.95	
Huntington Bayou at IH 610	12.0	7.51	7.39	
Sims Bayou	17.0	10.64	10.48	
Greens Bayou	34.0	21.29	20.95	
San Jacinto River at Lake Houston	5.6	3.51	3.45	

Tributary Totals	159.7	100.00	98.40	98.40
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Grand Totals	162.2911		100.00	
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\* Estimated from Newell et al. (1992)

**Table 4.38 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Arsenic**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	96	0.48	0.11	
0802 - Trinity River below Lake Livingston	36	0.18	0.04	
0901 - Cedar Bayou Tidal	150	0.74	0.17	
0902 - Cedar Bayou Above Tidal	32	0.16	0.04	
1001 - San Jacinto River Tidal	267	1.33	0.30	
1005 - Houston Ship Channel/San Jacinto R.	724	3.60	0.80	
1006 - Houston Ship Channel	3,239	16.10	3.58	
1007 - Houston Ship Channel/Buffalo Bayou	9,437	46.90	10.43	
1013 - Buffalo Bayou Tidal	803	3.99	0.89	
1014 - Buffalo Bayou Above Tidal	1,373	6.82	1.52	
1101 - Clear Creek Tidal	364	1.81	0.40	
1102 - Clear Creek Above Tidal	350	1.74	0.39	
1103 - Dickinson Bayou Tidal	119	0.59	0.13	
1104 - Dickinson Bayou Above Tidal	9	0.04	0.01	
1105 - Bastrop Bayou Tidal	15	0.07	0.02	
1107 - Chocolate Bayou Tidal	1	0.01	0.00	
1108 - Chocolate Bayou Above Tidal	2	0.01	0.00	
1113 - Armand Bayou Tidal	272	1.35	0.30	
2421 - Upper Galveston Bay	286	1.42	0.32	
2422 - Trinity Bay	24	0.12	0.03	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	247	1.23	0.27	
2425 - Clear Lake	19	0.10	0.02	
2426 - Tabbs Bay	171	0.85	0.19	
2427 - San Jacinto Bay	299	1.48	0.33	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	10	0.05	0.01	
2430 - Burnett Bay	0	0.00	0.00	
2431 - Moses Lake	281	1.40	0.31	
2432 - Chocolate Bay	119	0.59	0.13	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	3	0.01	0.00	
2437 - Texas City Ship Channel	382	1.90	0.42	
2438 - Bayport Channel	820	4.07	0.91	
2439 - Lower Galveston Bay	177	0.88	0.20	
Discharge Totals	20,123	100	22.25	22.25

Tributaries				
Trinity River at Romayor	50,668	72.05	56.02	
Buffalo Bayou at West Belt Dr.	2,332	3.32	2.58	
Whiteoak Bayou	2,496	3.55	2.76	
Brays Bayou	6,953	9.89	7.69	
Huntington Bayou at IH 610	1,747	2.48	1.93	
Sims Bayou	653	0.93	0.72	
Greens Bayou	1,585	2.25	1.75	
San Jacinto River at Lake Houston	3,894	5.54	4.31	

Tributary Totals	70,328	100	77.75	77.75
Grand Totals	90,451			100.00

**Table 4.39 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Cadmium**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
Waste Discharges				
0801 - Trinity River Tidal	33	0.51	0.12	
0802 - Trinity River below Lake Livingston	12	0.19	0.05	
0901 - Cedar Bayou Tidal	42	0.66	0.16	
0902 - Cedar Bayou Above Tidal	6	0.09	0.02	
1001 - San Jacinto River Tidal	59	0.93	0.22	
1005 - Houston Ship Channel/San Jacinto R.	140	2.20	0.53	
1006 - Houston Ship Channel	827	12.93	3.12	
1007 - Houston Ship Channel/Buffalo Bayou	3,213	50.23	12.11	
1013 - Buffalo Bayou Tidal	276	4.31	1.04	
1014 - Buffalo Bayou Above Tidal	470	7.34	1.77	
1101 - Clear Creek Tidal	125	1.95	0.47	
1102 - Clear Creek Above Tidal	120	1.88	0.45	
1103 - Dickinson Bayou Tidal	41	0.64	0.15	
1104 - Dickinson Bayou Above Tidal	3	0.05	0.01	
1105 - Bastrop Bayou Tidal	5	0.08	0.02	
1107 - Chocolate Bayou Tidal	0	0.01	0.00	
1108 - Chocolate Bayou Above Tidal	1	0.01	0.00	
1113 - Armand Bayou Tidal	93	1.46	0.35	
2421 - Upper Galveston Bay	92	1.44	0.35	
2422 - Trinity Bay	8	0.13	0.03	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	85	1.33	0.32	
2425 - Clear Lake	6	0.10	0.02	
2426 - Tabbs Bay	58	0.91	0.22	
2427 - San Jacinto Bay	59	0.92	0.22	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	2	0.03	0.01	
2430 - Burnett Bay	0	0.00	0.00	
2431 - Moses Lake	95	1.49	0.36	
2432 - Chocolate Bay	41	0.64	0.15	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	1	0.01	0.00	
2437 - Texas City Ship Channel	359	5.61	1.35	
2438 - Bayport Channel	62	0.98	0.24	
2439 - Lower Galveston Bay	60	0.93	0.23	
Discharge Totals	6,397	100	24.11	24.11

Tributaries				
Trinity River at Romayor	14,171	70.37	53.41	
Buffalo Bayou at West Belt Dr.	1,946	9.66	7.33	
Whiteoak Bayou	302	1.50	1.14	
Brays Bayou	453	2.25	1.71	
Huntington Bayou at IH 610	46	0.23	0.17	
Sims Bayou	275	1.37	1.04	
Greens Bayou	233	1.16	0.88	
San Jacinto River at Lake Houston	2,711	13.46	10.22	

Tributary Totals	20,137	100	75.89	75.89
Grand Totals	26,534			100.00

**Table 4.40 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Chromium**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
Waste Discharges				
0801 - Trinity River Tidal	128	0.40	0.06	
0802 - Trinity River below Lake Livingston	49	0.15	0.02	
0901 - Cedar Bayou Tidal	362	1.13	0.16	
0902 - Cedar Bayou Above Tidal	208	0.65	0.09	
1001 - San Jacinto River Tidal	657	2.04	0.29	
1005 - Houston Ship Channel/San Jacinto R.	2,468	7.67	1.11	
1006 - Houston Ship Channel	4,673	14.53	2.09	
1007 - Houston Ship Channel/Buffalo Bayou	15,327	47.65	6.86	
1013 - Buffalo Bayou Tidal	1,079	3.36	0.48	
1014 - Buffalo Bayou Above Tidal	1,842	5.73	0.82	
1101 - Clear Creek Tidal	488	1.52	0.22	
1102 - Clear Creek Above Tidal	470	1.46	0.21	
1103 - Dickinson Bayou Tidal	160	0.50	0.07	
1104 - Dickinson Bayou Above Tidal	12	0.04	0.01	
1105 - Bastrop Bayou Tidal	20	0.06	0.01	
1107 - Chocolate Bayou Tidal	102	0.32	0.05	
1108 - Chocolate Bayou Above Tidal	3	0.01	0.00	
1113 - Armand Bayou Tidal	365	1.14	0.16	
2421 - Upper Galveston Bay	360	1.12	0.16	
2422 - Trinity Bay	32	0.10	0.01	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	331	1.03	0.15	
2425 - Clear Lake	24	0.07	0.01	
2426 - Tabbs Bay	228	0.71	0.10	
2427 - San Jacinto Bay	315	0.98	0.14	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	6	0.02	0.00	
2430 - Burnett Bay	0	0.00	0.00	
2431 - Moses Lake	372	1.16	0.17	
2432 - Chocolate Bay	160	0.50	0.07	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	3	0.01	0.00	
2437 - Texas City Ship Channel	1,485	4.62	0.66	
2438 - Bayport Channel	121	0.38	0.05	
2439 - Lower Galveston Bay	316	0.98	0.14	
Discharge Totals	32,167	100	14.40	14.40

Tributaries				
Trinity River at Romayor	119,727	62.62	53.61	
Buffalo Bayou at West Belt Dr.	1,235	0.65	0.55	
Whiteoak Bayou	5,449	2.85	2.44	
Brays Bayou	7,752	4.05	3.47	
Huntington Bayou at IH 610	1,613	0.84	0.72	
Sims Bayou	6,508	3.40	2.91	
Greens Bayou	2,189	1.14	0.98	
San Jacinto River at Lake Houston	46,709	24.43	20.91	

Tributary Totals	191,182	100	85.60	85.60
Grand Totals	223,349			100.00

**Table 4.41 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Copper**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	111	0.40	0.05	
0802 - Trinity River below Lake Livingston	42	0.15	0.02	
0901 - Cedar Bayou Tidal	205	0.73	0.08	
0902 - Cedar Bayou Above Tidal	65	0.23	0.03	
1001 - San Jacinto River Tidal	301	1.08	0.12	
1005 - Houston Ship Channel/San Jacinto R.	926	3.31	0.38	
1006 - Houston Ship Channel	4,072	14.56	1.67	
1007 - Houston Ship Channel/Buffalo Bayou	11,175	39.97	4.58	
1013 - Buffalo Bayou Tidal	932	3.33	0.38	
1014 - Buffalo Bayou Above Tidal	1,591	5.69	0.65	
1101 - Clear Creek Tidal	420	1.50	0.17	
1102 - Clear Creek Above Tidal	404	1.45	0.17	
1103 - Dickinson Bayou Tidal	140	0.50	0.06	
1104 - Dickinson Bayou Above Tidal	10	0.04	0.00	
1105 - Bastrop Bayou Tidal	17	0.06	0.01	
1107 - Chocolate Bayou Tidal	9	0.03	0.00	
1108 - Chocolate Bayou Above Tidal	2	0.01	0.00	
1113 - Armand Bayou Tidal	314	1.12	0.13	
2421 - Upper Galveston Bay	312	1.12	0.13	
2422 - Trinity Bay	2,105	7.53	0.86	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	285	1.02	0.12	
2425 - Clear Lake	595	2.13	0.24	
2426 - Tabbs Bay	197	0.70	0.08	
2427 - San Jacinto Bay	616	2.20	0.25	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	9	0.03	0.00	
2430 - Burnett Bay	0	0.00	0.00	
2431 - Moses Lake	323	1.16	0.13	
2432 - Chocolate Bay	138	0.49	0.06	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	3	0.01	0.00	
2437 - Texas City Ship Channel	2,093	7.48	0.86	
2438 - Bayport Channel	164	0.59	0.07	
2439 - Lower Galveston Bay	384	1.37	0.16	
Discharge Totals	27,960	100	11.47	11.47

Tributaries				
Trinity River at Romayor	129,108	59.84	52.97	
Buffalo Bayou at West Belt Dr.	5,788	2.68	2.37	
Whiteoak Bayou	3,085	1.43	1.27	
Brays Bayou	4,375	2.03	1.80	
Huntington Bayou at IH 610	665	0.31	0.27	
Sims Bayou	5,611	2.60	2.30	
Greens Bayou	1,764	0.82	0.72	
San Jacinto River at Lake Houston	65,373	30.30	26.82	

Tributary Totals	215,769	100	88.53	88.53
Grand Totals	243,729			100.00

**Table 4.42 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Iron**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	2,091	0.49	0.18	
0802 - Trinity River below Lake Livingston	792	0.19	0.07	
0901 - Cedar Bayou Tidal	2,672	0.63	0.23	
0902 - Cedar Bayou Above Tidal	315	0.07	0.03	
1001 - San Jacinto River Tidal	4,010	0.95	0.35	
1005 - Houston Ship Channel/San Jacinto R.	8,756	2.07	0.76	
1006 - Houston Ship Channel	51,866	12.27	4.50	
1007 - Houston Ship Channel/Buffalo Bayou	203,015	48.02	17.60	
1013 - Buffalo Bayou Tidal	17,539	4.15	1.52	
1014 - Buffalo Bayou Above Tidal	29,881	7.07	2.59	
1101 - Clear Creek Tidal	7,952	1.88	0.69	
1102 - Clear Creek Above Tidal	7,647	1.81	0.66	
1103 - Dickinson Bayou Tidal	2,602	0.62	0.23	
1104 - Dickinson Bayou Above Tidal	191	0.05	0.02	
1105 - Bastrop Bayou Tidal	320	0.08	0.03	
1107 - Chocolate Bayou Tidal	26	0.01	0.00	
1108 - Chocolate Bayou Above Tidal	41	0.01	0.00	
1113 - Armand Bayou Tidal	5,945	1.41	0.52	
2421 - Upper Galveston Bay	5,709	1.35	0.49	
2422 - Trinity Bay	515	0.12	0.04	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	5,396	1.28	0.47	
2425 - Clear Lake	398	0.09	0.03	
2426 - Tabbs Bay	3,710	0.88	0.32	
2427 - San Jacinto Bay	1,293	0.31	0.11	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	124	0.03	0.01	
2430 - Burnett Bay	6	0.00	0.00	
2431 - Moses Lake	6,076	1.44	0.53	
2432 - Chocolate Bay	2,610	0.62	0.23	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	55	0.01	0.00	
2437 - Texas City Ship Channel	41,883	9.91	3.63	
2438 - Bayport Channel	5,549	1.31	0.48	
2439 - Lower Galveston Bay	3,806	0.90	0.33	
Discharge Totals	422,791	100	36.66	36.66

Tributaries				
Trinity River at Romayor	481,828	65.95	41.77	
Buffalo Bayou at West Belt Dr.	38,609	5.28	3.35	
Whiteoak Bayou	12,408	1.70	1.08	
Brays Bayou	7,862	1.08	0.68	
Huntington Bayou at IH 610	1,004	0.14	0.09	
Sims Bayou	5,751	0.79	0.50	
Greens Bayou	4,779	0.65	0.41	
San Jacinto River at Lake Houston	178,389	24.42	15.47	

Tributary Totals	730,630	100	63.34	63.34
Grand Totals	1,153,421			100.00

**Table 4.43 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Lead**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	134	0.53	0.03	
0802 - Trinity River below Lake Livingston	51	0.20	0.01	
0901 - Cedar Bayou Tidal	178	0.70	0.04	
0902 - Cedar Bayou Above Tidal	30	0.12	0.01	
1001 - San Jacinto River Tidal	215	0.85	0.04	
1005 - Houston Ship Channel/San Jacinto R.	547	2.16	0.11	
1006 - Houston Ship Channel	3,533	13.93	0.73	
1007 - Houston Ship Channel/Buffalo Bayou	13,176	51.94	2.72	
1013 - Buffalo Bayou Tidal	1,128	4.45	0.23	
1014 - Buffalo Bayou Above Tidal	1,917	7.56	0.40	
1101 - Clear Creek Tidal	511	2.02	0.11	
1102 - Clear Creek Above Tidal	492	1.94	0.10	
1103 - Dickinson Bayou Tidal	167	0.66	0.03	
1104 - Dickinson Bayou Above Tidal	12	0.05	0.00	
1105 - Bastrop Bayou Tidal	21	0.08	0.00	
1107 - Chocolate Bayou Tidal	2	0.01	0.00	
1108 - Chocolate Bayou Above Tidal	3	0.01	0.00	
1113 - Armand Bayou Tidal	382	1.51	0.08	
2421 - Upper Galveston Bay	374	1.47	0.08	
2422 - Trinity Bay	33	0.13	0.01	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	347	1.37	0.07	
2425 - Clear Lake	25	0.10	0.01	
2426 - Tabbs Bay	238	0.94	0.05	
2427 - San Jacinto Bay	273	1.08	0.06	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	7	0.03	0.00	
2430 - Burnett Bay	0	0.00	0.00	
2431 - Moses Lake	390	1.54	0.08	
2432 - Chocolate Bay	168	0.66	0.03	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	4	0.01	0.00	
2437 - Texas City Ship Channel	722	2.85	0.15	
2438 - Bayport Channel	41	0.16	0.01	
2439 - Lower Galveston Bay	245	0.96	0.05	
Discharge Totals	25,368	100	5.23	5.23

Tributaries				
Trinity River at Romayor	356,819	77.57	73.51	
Buffalo Bayou at West Belt Dr.	8,164	1.78	1.68	
Whiteoak Bayou	16,718	3.64	3.45	
Brays Bayou	9,878	2.15	2.04	
Huntington Bayou at IH 610	1,727	0.38	0.36	
Sims Bayou	14,493	3.15	2.99	
Greens Bayou	8,178	1.78	1.69	
San Jacinto River at Lake Houston	43,903	9.56	9.06	

Tributary Totals	459,380	100	94.77	94.77
Grand Totals	484,748			100.00

**Table 4.44 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Mercury**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
Waste Discharges				
0801 - Trinity River Tidal	0.896	0.41	0.02	
0802 - Trinity River below Lake Livingston	0.340	0.15	0.01	
0901 - Cedar Bayou Tidal	2.517	1.14	0.06	
0902 - Cedar Bayou Above Tidal	1.379	0.62	0.03	
1001 - San Jacinto River Tidal	2.591	1.17	0.06	
1005 - Houston Ship Channel/San Jacinto R.	7.199	3.26	0.16	
1006 - Houston Ship Channel	50.446	22.86	1.14	
1007 - Houston Ship Channel/Buffalo Bayou	88.926	40.29	2.02	
1013 - Buffalo Bayou Tidal	7.526	3.41	0.17	
1014 - Buffalo Bayou Above Tidal	12.879	5.84	0.29	
1101 - Clear Creek Tidal	3.408	1.54	0.08	
1102 - Clear Creek Above Tidal	3.277	1.48	0.07	
1103 - Dickinson Bayou Tidal	1.115	0.51	0.03	
1104 - Dickinson Bayou Above Tidal	0.082	0.04	0.00	
1105 - Bastrop Bayou Tidal	0.137	0.06	0.00	
1107 - Chocolate Bayou Tidal	0.011	0.00	0.00	
1108 - Chocolate Bayou Above Tidal	0.018	0.01	0.00	
1113 - Armand Bayou Tidal	2.548	1.15	0.06	
2421 - Upper Galveston Bay	2.628	1.19	0.06	
2422 - Trinity Bay	0.221	0.10	0.01	
2423 - East Bay	0.000	0.00	0.00	
2424 - West Bay	2.313	1.05	0.05	
2425 - Clear Lake	0.171	0.08	0.00	
2426 - Tabbs Bay	1.595	0.72	0.04	
2427 - San Jacinto Bay	6.737	3.05	0.15	
2428 - Black Duck Bay	0.000	0.00	0.00	
2429 - Scott Bay	0.053	0.02	0.00	
2430 - Burnett Bay	0.003	0.00	0.00	
2431 - Moses Lake	2.604	1.18	0.06	
2432 - Chocolate Bay	1.119	0.51	0.03	
2433 - Bastrop Bay/Oyster Lake	0.000	0.00	0.00	
2434 - Christmas Bay	0.000	0.00	0.00	
2435 - Drum Bay	0.000	0.00	0.00	
2436 - Barbours Cut	0.024	0.01	0.00	
2437 - Texas City Ship Channel	6.278	2.84	0.14	
2438 - Bayport Channel	10.035	4.55	0.23	
2439 - Lower Galveston Bay	1.631	0.74	0.04	
Discharge Totals	220.703	100	5.00	5.00

Tributaries				
Trinity River at Romayor	2,759.0	65.83	62.54	
Buffalo Bayou at West Belt Dr.	282.0	6.73	6.39	
Whiteoak Bayou	28.0	0.67	0.63	
Brays Bayou	126.0	3.01	2.86	
Huntington Bayou at IH 610	12.0	0.29	0.27	
Sims Bayou	82.0	1.96	1.86	
Greens Bayou	128.0	3.05	2.90	
San Jacinto River at Lake Houston	774.0	18.47	17.54	
Tributary Totals	4,191.0	100	95.00	95.00
Grand Totals	4,411.703			100.00

**Table 4.45 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for Total Zinc**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
<b>Waste Discharges</b>				
0801 - Trinity River Tidal	493	0.43	0.04	
0802 - Trinity River below Lake Livingston	187	0.16	0.02	
0901 - Cedar Bayou Tidal	760	0.67	0.07	
0902 - Cedar Bayou Above Tidal	178	0.16	0.02	
1001 - San Jacinto River Tidal	3,087	2.71	0.27	
1005 - Houston Ship Channel/San Jacinto R.	2,287	2.01	0.20	
1006 - Houston Ship Channel	17,773	15.59	1.55	
1007 - Houston Ship Channel/Buffalo Bayou	56,203	49.29	4.89	
1013 - Buffalo Bayou Tidal	4,143	3.63	0.36	
1014 - Buffalo Bayou Above Tidal	7,124	6.25	0.62	
1101 - Clear Creek Tidal	1,874	1.64	0.16	
1102 - Clear Creek Above Tidal	1,802	1.58	0.16	
1103 - Dickinson Bayou Tidal	640	0.56	0.06	
1104 - Dickinson Bayou Above Tidal	45	0.04	0.00	
1105 - Bastrop Bayou Tidal	75	0.07	0.01	
1107 - Chocolate Bayou Tidal	195	0.17	0.02	
1108 - Chocolate Bayou Above Tidal	10	0.01	0.00	
1113 - Armand Bayou Tidal	1,401	1.23	0.12	
2421 - Upper Galveston Bay	1,450	1.27	0.13	
2422 - Trinity Bay	122	0.11	0.01	
2423 - East Bay	0	0.00	0.00	
2424 - West Bay	1,272	1.12	0.11	
2425 - Clear Lake	94	0.08	0.01	
2426 - Tabbs Bay	878	0.77	0.08	
2427 - San Jacinto Bay	1,910	1.68	0.17	
2428 - Black Duck Bay	0	0.00	0.00	
2429 - Scott Bay	29	0.03	0.00	
2430 - Burnett Bay	1	0.00	0.00	
2431 - Moses Lake	1,432	1.26	0.12	
2432 - Chocolate Bay	615	0.54	0.05	
2433 - Bastrop Bay/Oyster Lake	0	0.00	0.00	
2434 - Christmas Bay	0	0.00	0.00	
2435 - Drum Bay	0	0.00	0.00	
2436 - Barbours Cut	13	0.01	0.00	
2437 - Texas City Ship Channel	6,023	5.28	0.52	
2438 - Bayport Channel	977	0.86	0.09	
2439 - Lower Galveston Bay	930	0.82	0.08	
Discharge Totals	114,024	100	9.93	9.93

Tributaries				
Trinity River at Romayor	639,010	61.78	55.65	
Buffalo Bayou at West Belt Dr.	30,444	2.94	2.65	
Whiteoak Bayou	53,831	5.20	4.69	
Brays Bayou	26,386	2.55	2.30	
Huntington Bayou at IH 610	15,964	1.54	1.39	
Sims Bayou	27,304	2.64	2.38	
Greens Bayou	9,255	0.89	0.81	
San Jacinto River at Lake Houston	232,100	22.44	20.21	

Tributary Totals	1,034,294	100	90.07	90.07
Grand Totals	1,148,318			100.00

**Table 4.46 - Loading from Waste Discharges (1990) and Tributaries (1968-88 Average) for PCB**

Point Source Characterization Project  
Galveston Bay National Estuary Program

Source	Annual Loading (kg/yr)	Percent Of Category (%)	Percent Of Total (%)	Category Percent Of Total (%)
Waste Discharges				
0801 - Trinity River Tidal	0.00	0.00	0.00	
0802 - Trinity River below Lake Livingston	0.00	0.00	0.00	
0901 - Cedar Bayou Tidal	0.00	0.00	0.00	
0902 - Cedar Bayou Above Tidal	0.00	0.00	0.00	
1001 - San Jacinto River Tidal	0.00	0.00	0.00	
1005 - Houston Ship Channel/San Jacinto R.	0.00	0.00	0.00	
1006 - Houston Ship Channel	15.69	100.00	13.63	
1007 - Houston Ship Channel/Buffalo Bayou	0.00	0.00	0.00	
1013 - Buffalo Bayou Tidal	0.00	0.00	0.00	
1014 - Buffalo Bayou Above Tidal	0.00	0.00	0.00	
1101 - Clear Creek Tidal	0.00	0.00	0.00	
1102 - Clear Creek Above Tidal	0.00	0.00	0.00	
1103 - Dickinson Bayou Tidal	0.00	0.00	0.00	
1104 - Dickinson Bayou Above Tidal	0.00	0.00	0.00	
1105 - Bastrop Bayou Tidal	0.00	0.00	0.00	
1107 - Chocolate Bayou Tidal	0.00	0.00	0.00	
1108 - Chocolate Bayou Above Tidal	0.00	0.00	0.00	
1113 - Armand Bayou Tidal	0.00	0.00	0.00	
2421 - Upper Galveston Bay	0.00	0.00	0.00	
2422 - Trinity Bay	0.00	0.00	0.00	
2423 - East Bay	0.00	0.00	0.00	
2424 - West Bay	0.00	0.00	0.00	
2425 - Clear Lake	0.00	0.00	0.00	
2426 - Tabbs Bay	0.00	0.00	0.00	
2427 - San Jacinto Bay	0.00	0.00	0.00	
2428 - Black Duck Bay	0.00	0.00	0.00	
2429 - Scott Bay	0.00	0.00	0.00	
2430 - Burnett Bay	0.00	0.00	0.00	
2431 - Moses Lake	0.00	0.00	0.00	
2432 - Chocolate Bay	0.00	0.00	0.00	
2433 - Bastrop Bay/Oyster Lake	0.00	0.00	0.00	
2434 - Christmas Bay	0.00	0.00	0.00	
2435 - Drum Bay	0.00	0.00	0.00	
2436 - Barbours Cut	0.00	0.00	0.00	
2437 - Texas City Ship Channel	0.00	0.00	0.00	
2438 - Bayport Channel	0.00	0.00	0.00	
2439 - Lower Galveston Bay	0.00	0.00	0.00	
Discharge Totals	15.69	100	13.63	13.63

Tributaries				
Trinity River at Romayor	38.03	38.27	33.05	
Buffalo Bayou at West Belt Dr.	0.00	0.00	0.00	
Whiteoak Bayou	8.23	8.28	7.15	
Brays Bayou	4.62	4.65	4.02	
Huntington Bayou at IH 610	12.63	12.71	10.98	
Sims Bayou	23.49	23.64	20.42	
Greens Bayou	12.37	12.45	10.75	
San Jacinto River at Lake Houston	0.00	0.00	0.00	

Tributary Totals	99.37	100	86.37	86.37
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Grand Totals	115.06		100.00	
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Table 4.47 - Active Permitted Tidal Disposal Brine Discharges in Galveston Bay in 1992

Point Source Characterization Project  
Galveston Bay National Estuary Program

TRC Railroad No.	Operator	Discharge Area	Latitude						Longitude						County	Map No.	Flow (bbl/day)	Flow (MG/yr)
			Deg	Min	Sec	Deg	Min	Sec	Deg	Min	Sec	Deg	Min	Sec				
00047	United Texas Corp.	Trinity Bay	29	40	57.8	94	52	6.81	Chambers	194-0	700	10.73						
00048	Fina Oil & Chemical Company	Trinity Bay							Chambers	74-0	1,510	23.15						
00064	Coastal Oil & Gas Corporation	Tabbs Bay	29	42	44	97	58	45	Harris	51-0	7,182	110.10						
00075	Exxon Company, U.S.A.	Trinity Bay	29	44	40	94	42	47	Chambers	70A	27,815	426.40						
00075	Exxon Company, U.S.A.	Trinity Bay	29	44	33.8	94	45	22.1	Chambers	70C	27,815	426.40						
00075	Exxon Company, U.S.A.	Trinity Bay	29	44	54.2	94	44	14.2	Chambers	70B	27,815	426.40						
00077	Exxon Company, U.S.A.	Tabbs Bay-Galveston Bay	29	42	51.2	94	59	1.87	Harris	258-0	14,393	220.64						
00080	Exxon Corp.	Trinity Bay/Cedar Point	29	40	41.2	94	45	18.8	Chambers	71C	464	7.11						
00080	Exxon Corp.	Galveston Bay	29	31	56.7	94	52	4.13	Chambers	71A	464	7.11						
00080	Exxon Corp.	Galveston Bay	29	32	7.7	94	50	15.1	Chambers	71B	464	7.11						
00081	Exxon Company, U.S.A.	Trinity Bay	29	44	30	94	49	53.8	Chambers	72-0	4,502	69.02						
00083	Ebb Tide Oil Co.	Tabbs Bay							Harris	53-0	18	0.28						
00086	French Production Inc.	Galveston Bay	29	37	39	94	50	6	Chambers	206-0	4,813	73.78						
00111	Marshall Petroleum, Inc.	Tabbs Bay	29	43	20	94	57	47	Harris	94-0	10	0.15						
00127	Shelton, Charles H.	Tabbs Bay	29	42	31	94	58	40	Harris	61-0	420	6.44						
00134	Sun Exploration and Production	Galveston Bay	29	36	58	94	51	39.1	Chambers	81-0	230	3.53						
00136	Sun Exploration and Production	Galveston Bay	29	38	14	94	42	53	Chambers	82-0	4,626	70.92						
00163	Ace Productions, Corp.	Trinity Bay							Chambers	89-0	3,474	53.26						
00164	Houston Oil Prod. Enterprises	Intercoastal-Galveston Bay							Galveston	117C	1,794	27.50						
00164	Houston Oil Prod. Enterprises	Intercoastal-Galveston Bay							Galveston	117A	1,794	27.50						
00164	Houston Oil Prod. Enterprises	Intercoastal-Galveston Bay							Galveston	117D	1,794	27.50						
00164	Houston Oil Prod. Enterprises	Intercoastal-Galveston Bay							Galveston	117E	1,794	27.50						
00164	Houston Oil Prod. Enterprises	Intercoastal-Galveston Bay							Galveston	117B	1,794	27.50						
00165	Union Oil Company of California	Dickinson Bayou/Galveston Bay	29	25	20	94	59	55	Galveston	114-0	138	2.12						
00166	Petro Vest, Inc.	Gum Bayou/Galveston Bay	29	27	55	95	0	45	Galveston	115-0	1,000	15.33						
00167	Petro Vest, Inc.	Gum Bayou/Galveston Bay	29	28	10	95	0	50	Galveston	116-0	1,000	15.33						
00172	Sun Exploration & Prod. Co.-LAF	Intercoastal Canal-Galveston Bay	29	29	23	94	33	46.8	Galveston	111-0	2,107	32.30						
00174	Sun Exploration & Prod. Co.-LAF	Galveston Bay	29	31	3	94	55	2	Chambers	83-0	13	0.20						
00586	Transco Energy Marketing Co.	Galveston Bay/Gulf of Mexico	29	27	52	94	39	6	Galveston	128-0	20	0.31						
00595	Poynor Corp.	Trinity Bay							Chambers	80-0	110	1.69						
00596	United Texas Corp.	Trinity Bay/Galveston Bay	29	43	48.7	94	49	38.2	Chambers	205-0	350	5.37						
00621	Energy Sources, Inc.	Galveston Bay	29	18	27.7	94	58	41.2	Galveston	97-0	0	0.00						
00632	Kansas Oil & Gas Corp.	Galveston Bay	29	37	52.9	94	57	14.9	Chambers	87-0	1,200	18.40						
00637	Denovo Oil & Gas, Inc.	Trinity Bay	29	44	55	94	49	40	Chambers	45-0	431	6.61						
00649	Dynaminic Production, Inc.	West Galveston Bay	29	16	56.3	95	2	42	Galveston	95-0	89	1.36						
00653	Coastal Plains Energy, Inc.	Galveston Bay	29	18	3.1	94	59	22.9	Galveston	92-0	2,700	41.39						
00659	Lone Oak Disposal Company	Trinity Bay	29	36	47.5	94	42	45.8	Chambers	77-0	40,488	620.68						
00666	American Exploration Company	Trinity Bay	29	40	45.3	94	41	44.8	Chambers	66-0	527	8.08						
00674	Chain Oil & Gas, Inc.	Tabbs Bay	29	42	55	94	57	32	Harris	63-0	1,200	18.40						
00675	Chain Oil & Gas, Inc.	Tabbs Bay	29	42	20	94	59	40	Harris	46-0	297	4.55						
00684	Pesetas Exploration Company	Tabbs Bay							Harris	59-0	600	9.20						
00688	Felmont Oil Corp.	Galveston Bay	28	44	5	95	28	3	Chambers	73-0	450	6.90						
00694	Crest Resources & Exploration	Trinity Bay	29	35	22	94	43	15.8	Chambers	67-0	150	2.30						
00710	Dan J. Harrison, III & Bruc	Galveston Bay	29	34	23.1	94	44	12.4	Chambers	76-0	360	5.52						
00712	TPET Management, Inc.	Trinity Bay	29	34	59.2	94	43	9.47	Chambers	88-0	83	1.27						
00734	Crest Resources & Exploration	Trinity Bay	29	32	42.4	94	39	43.6	Chambers	68-0	0	0.00						
00744	Nicor Exploration Company	Galveston Bay	29	35	14.5	94	52	17.9	Chambers	84-0	1,800	27.59						
00789	Daniel Resources Develop	Tabbs Bay	29	42	33	94	58	37	Harris	55-0	300	4.60						
00854	Texana Operating Company	Tabbs Bay	29	42	36	94	58	42.5	Harris	282-0	500	7.67						
00857	Claron Corp.	Galveston Bay	29	39	25	94	55	11	Chambers	279-0	75	1.15						
00901	Petrotex Engineering Co.	Galveston Bay	29	43	0	94	53	30	Chambers	286-0	700	10.73						
Totals																192,373	2,949.08	

## **4.6 SUMMARY COMMENTS**

Though comments have made throughout the text regarding the nature of these loading estimates, they are summarized here. First, each estimate of loading given, whether from waste discharge or from tributary, is only as good as the flows and analyses on which the calculations are based. Flow estimates with self-reporting data are assumed to be fairly accurate as are flow estimates from the USGS. Typographic errors were discovered with the self-reporting flow data and these were corrected to the extent possible, but without thorough checking of the numbers the estimates have to be considered approximate. Constituent concentrations likewise are assumed to be subject to good QA/QC control in the laboratory and are thus presumed to have the analytical variations typical of these constituents. It is instructive to note, however, that the analytical precision for the constituents reported herein as measured by the coefficient of variation varies from 20 to over 100 percent and that this precision decreases as the level of detection is approached. Loading estimates from waste discharges are those reported by the dischargers themselves in the self-reporting data, while loading estimates from tributaries are averages from two estimation methods found elsewhere to yield good results. Thus, overall the loading estimates where reported in waste discharge data are presumed to be about as good as laboratory QA/QC permits them to be as are the tributary loading estimates.

Second, no single constituent was reported in all waste discharges. TSS was reported by just over 90 percent of all permitted dischargers, BOD<sub>5</sub> by almost 70 percent, nitrogen by almost 60 percent, and oil and grease by 21 percent. For all other constituents, less than 10 percent of the dischargers reported them. Thus, loading estimates of pollutants from waste discharges reflect what was reported and the estimates based on TPCs, and they should be used with caution.

Third, the tributary loads reflect not only runoff into the river from rural and urban areas but also permitted and unpermitted point sources. For the major tributaries, they also reflect natural processes in Lake Livingston and Lake Houston that tend to reduce concentrations of constituents passing through the lakes.

Finally, the loading estimates for some constituents, particularly toxic pollutants, are highly dependent on the form monitored. Loads were estimated using the dissolved forms then converted to the total metal form using procedures contained in TWC documents. The precision of this conversion process is such that these estimates should be used with caution.